LITERATURE ON RADIATION EFFECT ON PLANT PHYSIOLOGY A BIBLIOMETRIC ANALYSIS 1994-1998

DISSERTATION

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CERTIFICATE

This is to certify that Miss Neelam Saghir has completed her dissertation entilled " **Radiation Effect on Plant Physiology**" A Bibliometric study. In partial fulfilment of the requirments for the degree of Master of Library and Information Scince. She has conducted the work under my supervision.

(S.M.K.Q.Zaidi)
Reader

DEDICATED TO
MY PARENTS
AND BROTHER

CONTENT

ACKNOWLEDGEMENT

First of all my head is bowed before Almighty GOD whose mercy bestowed on me the oppurtunity and privilege of the completion of this dissertation. The work took its present shape solely and exclusively due to HIS kindness.

I pay my heartiest gratitude and thanks to Mr. SYED MUSTAFA, K.Q. ZAIDI, Reader, Department of Library and Information Science, Aligarh Muslim University, Aligarh, my supervisor, who despite his busy schedule provided me with all possible help, valuable guidance and perceptive advice and whenever any hurdle came to deter my path in completion of this work, he took personal interest in bailing me out.

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Neelam Saghir

(NEELAM SAGHIR)

INTRODUCTION

The main aim of choosing this topic Radiation effect on plant physiology was that it offers a wide scope of study. Although a widespread research is already being carried out on this area but the study is not yet complete. As more people are becoming aware of the importance of this subject, a lot of people are now indulging in research in the field of Plant Physiology.

Plant development represents a regular pattern of growth and differentiation process, including numerous correlative phenomenon. Exposure of green plants to ionising radiations may upset this balance and induce cytological and morphological changes in cell which are usually reflected as morphogenetic abnormalities.

In recent years, ionoising radiations have been greately exploited in understanding various fundamental problems of life process and in improving crops through mutation and subsequent breeding of those mutants. The ability of ionising radiations to speed up the frequency of teralogical changes has been utilised to throw light

on the morphological nature of the organ. Radiation, may therefore be considered as a valuable tool for developmental analysis, particularly where many events in growth are observed (or not observed) because of the time factor.

A considerable amount of literature is presently available on the effects of ionising radiations on plants (Johnson 1956; Gunkel and Sparrow 1954, 1961; Sparrow and Gunkel, 1956, Gorden, 1957; Konzak, 1957; Smith 1958; Bacq and Alexander, 1961; Sparrow et al, 1971). As pointed out by Gunkel (1957.1965) the responce elicited depends upon the species. Its over all physiological condition, radiosensitivity, dose rate and various environmental conditions.

After choosing the topic, the references were copied on the cards of 3"x5". The literature or the references were taken from the last five years i.e. 1994-98. For the bibliometrical analysis different tables were prepared. This bibliometrical analysis is done at two different stages or levels.

In the first level I have tried to find out core

journals, the most productive authors, the authorship pattern, the highly used language, the most productive country and the Institute which have contributed in large number.

In the second level of citation analysis was done. It is basically used to find the link between the cited and citing documents. Here also different tables were formulated to identify the most cited author, most cited journal, the most used forms of the documents and the year in which the most citations appeared.

The dissertation or the whole study is divided into different chapters. First chapter gives an overview of Bibliometrics by defining it, giving scope, applications and fundamental laws. Chapter two gives an understanding of the science of plant physiology. Chapter three deals with matrials and methodology. Chapter four deals with tables, analysis and application of bibliometric laws. The last is the conclusion chapter.

CHAPTER 1

INTRODUCTION

Bibliometrics is relatively a subject of recent origin. It is that branch of information science which lies between the border areas of the social and physical sciences. Its a quantitative study of various aspects of literature in a topic and is used to identify the pattern of publication, authorship, citations and/or secondary journal coverage with the objective of getting an insight into the dynamics of the growth of knowledge in the areas under consideration. This all leads to the better organisation of information resources which is essential for its most effective and efficient use. Biblometrics today has attained sophistication and complexity having national, international and interdisciplinary character.

ORIGIN

In the beginning measurement was related mainly to length, breadth, weight and volume. As science progressed, need aroused to measure innumerable other phenomena. For a long time measurement was the field of study mainly of physical scientists and mathematicians.

Gradually it started spreading to other areas of science and to social sciences as well and subjects like ECONOMETRICS, PSYCHOMETRICS, SOCIOMETRIC, INFORMETRICS developed where mathematical and statistical calculus have been systematically applied to study and solve problems in the fields of Economics, Psychology, Sociology and Information science.

Statistical analysis when applied to a field of activity generates a new field derived out of fusion. For example, when statistical distributions are applied to library organisation and services, then it is called LIBRAMETRICS. Similarly when it is applied to Bibliographical organisations and services, known as BIBLOMETRICS and also when it is applied to information systems and services , it is called as INFORMETRICS. The organisation of science and its productivity analysis gives use to SCIENTOMETRICS. It basically helps in utilisation of information in a productive manner and also helps to identity areas for further research. Besides it helps effective and efficient management of information services in the ever changing context and environment.

The first study on bibliometrics was conducted in 1917 by COLE AND EALE ON THE HISTORY OF COMPETITIVE ANATOMY PART-I : A STATISTICAL ANALYSIS this was the first time the expression statistical Analysis has been used in the literature.

In 1923 the second study was made by HULME. HULME was the first to use the expression STATISTICAL BIBLIOGRAPHY instead of statistical analysis.

In 1927 the work of GROSS and GROSS was considered to be the third study in the field based on citation analysis the term Statistical Bibliography was also used by HENKLE (1938), GOSNELL (1943-44), BARKER (1966).

In 1969 ALAN PRITCHARD coined the term BIBLOMETRICS in place of Statistical Bibliography. He did not find the term Statistical Bibliography at all satisfactory as used by HULME. According to him the term is clumsy, not very descriptive and can be confused with Statistics itself or Bibliographic on Statistics.

BIBLOMETRICS

Etyomologically BIBLOMETRICS is composed of two distinct part i.e. BIBLO and METRICS. BIBLO means BOOKS and METRICS or METRICOS means measurements, thus Biblometrics means the science of measurement pertaining to books or documents.

DEFINITIONS

HULME

"The purpose of Statistical Bibliography is shed light on the process of written communication and the nature and course of development of a discipline by means of counting and analysis its various facets of written communication."

RAISING

"The assembling and interpretation statistics relating to books and periodical..... use of books and journal and to ascertain in many local situation the general use of book and journal".

PRITCHARD

"The application of mathematical method to books and other media of communication".

"It is that branch of information theory that attempts to analyse quantitatively the properties and behavior of recorded knowledge".

BRITISH STANDARD INSTITUTION

"Defines Bibliometrics as the study of the use of documents and patterns of publication in which mathematical and statistical methods have been applied".

HAWKINS

"Biblometrics as qualitative analysis of the bibliographic features of a body of literature".

POTTER

"Biblometrics as the study and measurements of the publication patterns of all forms of written communication and their relationship".

SCOPE AND PURPOSE

Hulme clearly stated the purpose of biblometrics as to shed light on the process of written communication and the nature and course of development of a discipline by means of counting and analysing the various facets of written communication.

Pitchard has also defines its purpose in a slightly different way as stated by Hulme.

According to O' CONNOR AND UOOS the scope of Biblometrics includes studying the relationship within a literature (citation studies) of describing a literature. Typically, there description focus on consistent patterns involving authors, monographs, journal of subject/language.

RONALD STEVENS has considered biblometric as a quantitative science and divided its scope into two basic categories-

1- Descriptive Biblometric or productivity count which includes:

(a) Geographic

(b) time period

(c) discipline

2- Evaluative Biblometric or literature usage count which includes:

(a) reference count

(b) citation count

The Descriptive Biblometrics further includes the study of the number of publications in a given field or productivity literature in the field for the purpose of comparing the amount of production during different periods, or the amount produced in different subdivisions of the field. This kind of study made by a count of the papers, books and other writing in the field or often by a count of these writing which have been abstracted in a specialised abstracting journal.

The Evaluative Biblometrics includes the study of literature used by research worker in a given field. Such a study is often made by counting the references cited by a large number of research workers in their paper.

OBJECTIVE

B.C.BROOKS is of the opinion that the quantitative studies have five general objectives:-

(i) Design of more economic information systems and networks;

(ii) Improvement of efficiency rates of information handling process;

(iii) Identification and measurement of deficiencies in biblographic services;

(iv) Predicting of publishing trends;

(v) Discovery and elucidation of empirical laws that can provide a basis for developing a theory of information science.

APPLICATIONS OF BIBLOMETRICS

The Biblometrics techniques are being applied to get factual and accurate data in the transfer and

handling of information. GROSS and GROSS were the first to apply biblometric techniques to the problem of chemical library building. Since then a number of works have been undertaken for different purposes.

RAISING has applied their method to evaluate the relation importance of scientific journals.

BROWN has studied the list of serials most frequently cited in eight major scientific fields and suggested increase library cooperation to satisfy the scientist's need.

GOFFMAN AND MORRIS have applied Bradford's law of journal acquisitions in the libraries.

DONOGUE has used three biblometric techniques to study the literature of information science for library measurements purposes.

GARFIELD has reported an analysis of more than 5 million citations in the references of the journal articles covered by science citation ideas during 1974 and he has presented a ranked list of highly cited

journals by the total citation received.

LAL AND RAY have used the biblometric techniques to measure the relative scientific activity of the of the world in the field of horticulture.

BIBLOMETRIC LAWS

The three fundamental laws which laid the formation of biblometrics are:-

1- Lotka's Inverse Square law of Scientific Productivity:

2- Bradford's law of Scattering of Scientific Pa pers:

3- Zipf's law of Word Occurrence:

LOTKA'S INVERSE SQUARE LAW

Alfred J. Lotka in 1926 proposed his inverse

square law. His law provided fundamental theoretical base for biblometric studies involving authorship means that his inverse square law correlate contributions of scientific papers to their number of contributions. He was interested in determining "the men of different calibre contribute to the progress of science". For this he collected index of chemical abstract 1907-1916 and counted the number of names against which appeared 1,2,3... etc. entries. He tabulated the data for 6,891 names, beginning with letter A and B. Similarly the data from the Auuballi's Gestricftafeln der Physik was also collected 1325 physicists. Lotka then plotted the graph on a logarithmic scale, the number of author against the number of contributions made by each author on the basis of their data, Lotka decided a general equation, for the relation between the frequency 'y' of persons making 'x' contributions as follows-

x^.y = constant

In other words for every two authors contributing the article, 25 will contribute two article about 11 will contribute 3 article and 6 will contribute 4 articles and so on and forth.

EXAMPLE :-

S.No.	Authors	Articles
1	100	1
2	25	2
3	11	3
4	6	4
5	4	5

Author ~ $1/n^2$

n = number of paper

Author contributing 2 papers = No. of author contributing paper/n^2

= 100/2x2

= 100/4

= 25

Author contributing 3 papers = No. of author contributing paper/n^2

= 100/3x3

= 100/9

= 11

BRADFORD LAW OF SCATTERING

Samuel Clement Bradford first formulated his law in 1934 but it did not receive wide attention until the publication of his book "Documentation" in 1948. He while searching for papers in Applied Geophysics and Lubrication noticed that the scatter of such papers the scientific journal had a common pattern. He prepared list of journals arranged by decreasing order of source items contributed by the journal to the bibliographies. Bradford identified that they can be divided into clear three zones, so that each zone produces 1/3 of the total relevant papers. The first, the nucleus zone-contains a small number of highly productive journals say n1. The second zone contains a large number of moderately productive journal, say n2, and the outer zone containing a still larger number of journal of low productivity, say n3. He evaluated his law of scatter as:

$$n1:n1:n3 = 1:\sim:\sim^2$$

A physical analogy of the situation may be that the comet, with the nucleus representing the core journals of a discipline and the debris and the gas

molecules of the tail representing additional journals that also publish sometimes material relevant to the subject. As subjects or disciplines get larger the pursuit of complete coverage becomes difficult.

APPLICATION OF BRADFORD'S LAW

1- Completeness of Bibliography.

2- It helps in serial control.

3- It helps in library services to users.

4- It gives strength to pare to law.

ZIPF'S LAW OF WORD OCCURRENCE

This law envisaged by George K. Zipf is based on frequency of occurrence of words in a text and their ranking in descending order.

Zipf's law states that "if words occurring in natural language text of sizeable length were listed in the order of decreasing frequency, then the rank of any given word in the list would be inversely proportional to the frequency of occurrences of the word".

Zipf's equation is:

$$rf = c$$

where r and f are rank and frequency of words, respectively and c is a constant.

EXAMPLE :-

The analysis of the novel Llysses by using Zipf's law is given below-

The novel contains 2,60,430 totally running words of which 28,899 unique word forms. A frequency table of words that were in the novel, arranged in the order of decreasing frequency.

By analysis it revealed that the product of a word (r) and its frequency (6) was a constant. The length of most frequent word occurred 2,653 times; the underneath word occurred 265 times; the two hundred word occurred 133 times and so on.

In other words, Zipf's analysed that the words and arranged there in a descending order of frequency and multiplied the numerical value of each rank (r) with its frequency (f) and arrived at a product (c)

OTHER LAWS ARE:

i) Price's Square Law of Scientific Productivity

This law state that "half of the scientific papers are contributed by the square root of the total of scientific authors. In other other words , $N^{1/2}$ yield a fraction 1/2 of the items. This phenomenon is associated with the occurence of invisible colleges. This law is some times called 'Rousscaus law' since Jean Jacques Rousscau had mentioned the same thing quite clearly in his 'Social Contract' about the size of elite, i.e. those participating in the government. Egghe and Roussean argue that Price's law is not generally valid. This can also be treated as an extension of the succcess-breed-success principal originally developed by Simon in 1955.

ii. Garfield's Law of Concetration

Garfield talked about the number of journals involved in publishing the literature of a single field. He did not say anything about how much the journals in one field might overlap with other fields. In fact, there is a

significant degree of overlap. Several studies have shown that relatively few journals are involved in the publishing of an overwhelming majority of the material in a subject. A study of the Science Citation Index (SCI) database showed that 500 journals accounted for 70% of the material index in SCI in 1969. Almost half of the 3.85 million references published that year was found to emanate from only 250 journals. This type of evidence makes it possible to move from Bradford's law of dispersion to Grafield's law of concentration.

The law state that "a basic concentration of journals is the common core our nucleus of all fields". In other words the tail of the literature of one discipline consists, in a large part, of the cores of the leterature of the other disciplines. So large is the overlap among disciples that the core literature of all scientific disciplines involves a group of not more than 1000 journals.

iii.Sengupta's Law of Bibliometrics

This basically an extension of Bradford's Law. It states that "during phases of rapid growth of knowledge in a scientific disciplne, articles of interest to that discipilne

appear in increasing number of periodicals distant from that field. Mathematically Sengupta's law stands in the following from:

$$f(x+Y)=a+b \log(x+y)$$

Where f(x+y) is the cumulative number of references as contained in the first (x+y) most productive journals, x indicate number of journals in the same discipline and y stands for number of journals of unrelated disciplines (v>x) and a and b are two constants.

Ravendra Rao summarises other empirical laws in one of his papers and those who are interested can go through the reference. He has also listed more important bibliometric models.

CITATION ANALYSIS

The primary function of citation is to provide "a connection between two documents, one which cites and the other which is cited". There are umpteen number of reasons for giving citations. Weinstok, Lipetz, Moravscik,

Murugesan, Hodges, Oppenheim and Renn, Finney, Forest and Thorne have all attempted to explore the possibie reasons to for giving citations. They include the positive and negative reasons for inclusion. However, it has to be concede that if the reason is positive, there is bound to have some connection between the citing and cited paper. The first recorded citation analysis was a study by P.K.L. Gross and E.M. GRoss npublished in 1927 in order to determine the journals to be subscribed to and the back volumes to be acquired for the library of Pomona College. They studied the citation frequency in the reference given in the Journal of the American Chemical society. Citation analysis is very often fruitfully applied to derive the following benefits:

(a) *To lead the reader to further studies in the field*

This is perhaps, the primary purpose of citations. Readers can verify the correctness of information and therby convince themselves.

(b) For the prepration of bibliographies

The first use of citation indexing was made in Sheperd's Citations published in 1873. This technique of citation indexing has been perfected by Eugene Gerfield

and others since the early 1960s. It is a fact that compilation of bibliographies in new fields is really difficult. In such circumstances, analysis of citation articles may be the only way to gather information. The very fact that the citations have been verified, evaluated and recommended by authors who are experts in their own fields make them all the more acceptable for inclusions in a bibliography.

(c) To study the use pattern of different types of documents

Citations given may be of books, journal articles, reports, stsndards, theses/dissertations etc. The relative use of each of these types can be ascertained based on the frequency of citations. For example, various citatonstudies have shown that journal articles are the most preferred source cunsulted by scientists since they constitute about 70-80% of the total citations. Similarly citation practices among social scientists indicates that they give equal importance to books and journals.

(d) To find out the relative use of different languages

Since English has emerged as a world language, especially science and technology, there is a

predominance of English language publications in all branches. This can easily be understood from citation analysis. In the mid-sxties, for instance, the share of English language papers in Mathematics and Chemistry was more than 50%. Russian occupied the second position with about about 20 percent followed by German and French.

Citation practices have also shown that the relative amount of literature in different subjects produced by different countries changes with time. It has been observed that German has declined very much in the 20th century, especially in hte field of Chemistry where publicatons in this language reigned supreme.

(e) To study the use of literature from different countries

Form the citations, the country of their origin can be identified in all types of materials like journal articles, books, reports etc. In many sububject areas, U.S. Publications are found to be used more heavily. In medicine, biochemistry, physiology and pharmacology, Sengupta had identified the role played by U.S. journals. Journals of U.K. occupied the second position, but they

come nowhere near the American counteraprts in the frequency of use. Similarly, Martyn and Gilchrist had found that in sixties one in every eight citations was to British publicaton. Some of the user studies in India have shoen that Indian publications are also equally cited in certain subjects.

(f) To study the scattering of subjects

Studies about the dispersion or scattring of subjects in different sources as evident by citation analysis have brought out interisting results. For example,

i- Social science and arts subjects show a wider scatter of publications than the sciences.

ii- Research publications in technology show a greater dispersion than those in science.

iii- A new branch of science, especially an interdisciplinary one, shows a greater dispersion than an older branch of science.

iv- There can be differences in scatter between sub-fields within a subject as also among major subjects.

v- The rate of scatter within the same subject alters with time.

(g) To decide the obsolescence rate of documents in different subjects

Citaitons in subsequent literature and uasge patterns in libraries are considered as two indicators of the obsolescence of literature. Analysis of citations by the age of cited document can show the useful life of a document. In order to measure the decay or obscolescence rate of documents, the concept of 'half life' has been borrowed from Nuclear physics. Using the measure Burton and Kebler had suggested a range of half lives for different subjects. The fast growing subjects would have lesser half lives compared to established disciplines. The above study ahd shown the half life of Metallurgical Engineering as 3.9 while that of Botany is 10 years. These time scales are highly useful in the planning of library holdings.

(h) To determine the interdependence and lineage of subjects

The interdependence of basic and applied fields can

be understood by citation studies. Establishment of this interdependence can be of use in the aquisition policy of special libraries or information centres. The analysis of citations of the 'Annual Review of Medicine' for the years 1965-69 by I.N. Sengupta has established the contribution made by journals in the fields of biochemistry and physiology to the medical research. Further studies by him have brought us to light the mutual contribution of biochemistry, physiology and microbiology.

As far as lineage of subjects is concerned, Garfields experiments in citation indexes have very much contributed in mapping the history of many of them.

(i) To prepare ranked list of periodicals

Ranked list of periodicals can be prepared by two methods:

(1) by actual citation counting, and

(2) by counting the number of entries in the indexing and abstracting periodicals.

In the first method, information is collected from the refercenes cited in the source articles. By studying the average number of citations, one can develop a list of cited journals in the ranked order.

In the second method, the number of items contributed by different periodicals during a specific period of time is calculated from the secondary source and the ranked list is prepared based on the productivity of journals. Such ranked lists are very often used as guidelines in the aquisition of periodicals and other materials in the library.

(j) To study the rate of collaborative research

Collaborative research can be effectively measured from the number of authors in the papers. Such studies can be conducted to understand global trends, natonal trends or trends in different subjects. Studies in this direction have indicated that collaboration varies from discipline to discipline, within the same discipline from time to time, and from country to country. However, the extent of collaboration may not be revealed from

the citations. Efforts in this direction have been made by Ajiferuke et al who have attempted to define 'good collaboration' measures.

(k) For the analysis of scientific journals

Citaton analysis provide a number of interesting and useful insights into the networking of journals. These insights are developed from five different citation measures, which are perfected by Institute for Scientific Information.

i- Citation rate of a journal:

This is the number of times a journal has been cited. It can consist of all the references to the cited journal counting even duplicate references from the same source source article as a separate citation. It can also be calculated by counting only the number of source articles that cited the journal. A third method of calculating the citation that is followed by ISI is by counting the number of references to the cited journal,

but treating duplicate references from the same source article as only a single citation link.

ii- Impact factor:

Impact factor (IF) is the average citation rate of a journal's articles. It is basically a ratio between the citation rate of the journal and its citatio pottential. Citation rate is defined as the number of times cited, whereas citation pottential is defined as the number of citable items published.

Therefore IF= the number of times the journal was cited/the number of citable items the journal published.

Thus, the 1986 impact factor of Journal X would be calculated by dividing the number of all science citation index, Social science citation index and Arts and Humanities citation index Source journals' 1986 citations of articles journal X published in 1984 and 1985 by the number of items it published in 1984 and 1985.

Perviously, it was not possible to calculate the IF of journals not covered by Science Citation Index. But

now a new formula for the determination of IF for journals which are not incorporated in it has been worked out by B.K. Sen and others. The method is discussed in a short communication in 'Journal of Documentation' 45(2) 1989.

iii- Self-citing rate:

This is a measurment of the frequency with which journals cite themselves. It shows what percentage of a Journal's reference cite articles it published.

iv- Self-cited rate:

This, again is a measurment of self-citation. It showa what percentage of citations received by a journal oririnated in articles published by the journal. These self-citation rates serve as indexes to the newness, size and isolation of the intellectual universe in which a journal operates.

v- Immediacy index:

This is a method of showing how rapidly the materials published by a journal are picked up and used. It is calculated by counting the number of citations received by articles in a journal during the year in which they are published.

The results of the citation measures carried out by ISI are published regularly in the Journal Citation Reports (JCR) of ISI.

Citation counts have also been streched even to measure the productivity in other areas. As Broadus points out, "Over the last two decades, tabulation of citations have been used to measure the importance of academic departments, but specially of indivudual scholars and the contribution they made to their respective fields". In addition to the above areas of application, citation analysis has also lead to the development of such concepts like bibliographic coupling put forward by Kessler and co-citation by Small. Co-citaion is getting renewed attention now-a-days.

Citation analysis is a suitable technique to evaluate the contribution of scientists and predict the major contributions in any field of study. The analysis helps to identify classics and study mechanism of development of a subject. The combination of quantitative and qualitative dimensions can be seen in citation analysis, which qualitatively analyses the link between the cited and citing documents and quantitatively studies the variables. By citation analysis one can evaluate and interpret citations received by articles, authors, institutions and other aggregates of scientific activities. It has become an accepted practice in almost all scientific communications.

Citation analysis has become a major thrust area of bibliometrical research today. Citation analysis as a tool was initially used to identify the core periodicals in a subject through counting the citations appended at the end of each scientific article from a group of primary periodicals.

EC WHITE is of the opinion that, citation analysis plays a prominent role for easy identification of earlier research. Citation analysis performs the following

functions

1- Recognising Pioneers;

2- Crediting related work;

3- Identifying methodology;

4- Substantiating claims;

5- Providing leads to poorly indexed works;

6- Authenticating data;

7- Providing background reading.

Citation analysis has three dimensions

(a) Co-Citation- Two citations are cited together;

(b) Direct Citation- Which establishes the relationship between document and the researchers who use them.

(c) Bibliographic Coupling- The relation of two documents by virtue of their joint descent from the third.

CO-CITATION

The concept of Co-Citation was given by SMALL AND MAKSHAKOUA in 1973. Cocitation is defined as the frequency with which two documents are cited together. The Cocitative frequency of two papers can be determined by comparing lists of citing documents and isolating identical entries. The number of identical citing items defines the strength of Cocitation between the cited papers. Cocitation is the relationship established by the citing authors. Cocitation links cited documents. It can be assumed that frequently cited papers represents the concepts in a discipline. Cocitation patterns can be used to bring out in a detail the relationship between these key ideas and follow the growth/changes occurring in discipline. Through the study of these changing structure, Cocitation can be used as a tool for measuring the development of scientific fields.

DIRECT CITATION

Direct citation counting is technique that determines how many citations a given document, author, journal etc. has received over a period of time. The rationale for this is that citations are objective indicators of use and therefore an article, author, journal that is frequently cited is more useful or productive than one that is less frequently cited.

BIBLIOGRAPHIC COUPLING

The concept of Bibliographic coupling was conceived by FANO. It is a technique for identifying the themes of a document from its citations or references. It is the number of common references cited in two document that indicates the degree of similarity of contents of the citing papers. Two source documents containing a large number of common references are said to have a high coupling strength and are likely to be on the same topic.

INDIAN CONTRIBUTION TO THE DEVELOPMENT OF BIBLIOMETRICS

In terms of the growth of this subject, India has made many attempts and can find a place as a contributor among the world's prominent bibliometrically advanced countries U.S., U.K., Canada and others.

India, has to begin with FID committe on Informetrics, established in Delhi, around 1985, which also promotes bibliometrics. Many books have appeared dealing with bibliometrics, including those by I.N. Sengupta, I.K. Ravichandra Rao, B.M. Gupta, S. Subba Rao, Mohamed Taher, etc. There are at least dozens of Indian scholars who have published their contributions in Indian and international sources, to name a few: B. Maheshwarappa, B. Guha, R. Shalini Urs, B.K. Sen, M. Mahapatra, K. Meghanatha Reddy, K.S. Ragahavan.

Coming to teaching this subject, It is a full paper, in some universities, and as a part of research method in some universities. Whereas some universities have not yet updated their syllabus, and hence have failed to include quantitative and bibliometric methods in

the program.

Extensive bibliographies have appeared in Indian Library science periodicals, like the IASLIC Bulletin, Annals of Library & Information Science, etc. IASLIC has its seminar on this topic in 1985, DRTC had its first All India conference in 1969 (as the theme of its annual seminar), again, DRTC conducted Refresher Seminar in 1981, and there have been many more programs conducted all over the country.

Indian bibliometricians do regularly attend the international bibliometric conferences, and the recent meet held at Chicago had many Indians participating in the program. And as a part of the exchange of idea programs, bibliometricians from other countries have continuously visited India, and those include: Leo Egghe, F.W. Lancaster, and others. Indians who are now in the United States, and other countries have also contributed to the development of the field, prominent among these are Chandra Prabha and K. Subramanyam, who are living in the U.S., and have published extensively.

CHAPTER 2

PLANT PHYSIOLOGY

Plant physiology is the science that deals with various vital phenomenon in plants. It studies different processes and functions of the plants and their response to the environmental conditions. Plant physiology can be said to have three functional domains.

First domain concerns analysing and studying plant processes i.e. photosynthesis, respiration, ion absorption assimilation, flowering etc.

Second domain concerns analysing and studying different plant functions or functions carried out by different plant organs i.e. tissues, cells and other cellular sub-organs i.e. cell wall, cell membrane, protoplasm, cytoplasm, ribosomes etc.

Third domain concerns analysing and studying the effects of external factors or environmental factors i.e. temperature, pressure, light, water, humidity etc. since these factors largely influence plant life.

The basic aim of the science of plant physiology

is to develope a comprehensive knowledge and understanding of the plant life, phenomenon associated with then and factors affecting them i.e. their growth and development.

FIRST DOMAIN

PHOTOSYNTHESIS

It is a process of formation of carbon compounds (carbohydrate) from Carbondioxide (CO_2) and water (H_2O) in the presence of light and chlorophyll and substances present in the leaves of green plants and releasing oxygen and water as by-products.

The basic equation of photosynthesis as derived by Ruben and Kamen in 1941 is :

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} 6C_6H_{12}O_6 + 6O_2 + 6H_2O$$

This process of photosynthesis is the very basis of existence of all kinds of life on planet earth as the carbon compound formed in it called carbohydrate and

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oxygen are said to be the essential pillars of life form.

It was further demonstrated by Blackman that the process of photosynthesis was not light dependent only. Rather, it happened in two phases, one phase being light dependent phase often referred to by light reaction or Hill reaction and the other phase being light independent phase often referred to as Dark reaction or Blackman reaction.

His studies further established that these light reaction phase and dark reaction phase were essentially independent but somehow were interlinked, often affecting or limiting the performance of each other.

RESPIRATION

It is a vital process which occurs in all living cells of the plants. It is the very process by which the plants get the energy which they require for their different functions/activities.

In the basic technical terms the respiration can be defined as an exothermic oxidation reaction. i.e. a

reaction in which energy is evolved and bigger molecules are broken into smaller ones.

Respiration mainly occurs in leaves, stems and also in buds germinating seedlings. In respiration oxygen is absorbed by plant cells and the complex carbon molecules (carbohydrates) are broken and decomposed to smaller simpler substances with the action of oxygen (oxidation) releasing huge amount of energy and by-products like carbondioxide (CO_2) and water (H_2O).

The reaction for respiration is:

$$C6H12O6 + 6O2 \longrightarrow 6H2O + 6H2O + 686kcal$$

Energy released

SIGNIFICANCE OF RESPIRATION

1- It release energy which is consumed in various metabolic processes essential for plant life and cell division.

2- It brings about the formation of other necessary compounds participating and important cell constituents.

3- It converts insoluble food into soluble form.

4- It liberates CO_2 and plays a part actively in making the balance of carbon cycle in nature.

5- It converts stored energy (potential energy) into usable form (kinetic energy).

ION ABSORPTION

For their growth and development the plant need some mineral salts also. These mineral salts are present in the soil. So the plants have to suck, absorb these minerals from the soil. Plants can suck the minerals from the soil in two ways i.e. there are two types of absorption:-

(a) Passive adsorption
(b) Active absorption

PASSIVE ABSORPTION can be defined as the absorption of solute cells according to ordinary laws of diffusion. We can also call passive absorption, physical

absorption. Different theories were give about passive adsorption out of which Ion Exchange theory (Ion Absorption theory) was the one.

Ions from external solutions in which the tissue is immersed exchange with the ions absorbed on the surface of the cell wall on membranes of the tissue.

FLOWERING

Flowering is an important phase of life cycle of plants because it is the transition from the vegetative growth to reproductive phase which involves several changes in the physiology of the plant. Flowering is a decisive stage. It requires definite period of vegetative growth. This period may vary form plant to plant. e.g. a fruit bearing tree requires several years to flower while an annual herb flowers in a few months only.

Flowering, as established after comprehensive research, exhibit a unique phenomenon called photoperiodism or rather is controlled by the photoperiodic response of the plant. Depending upon the

photoperiodic response the plants can be classified under 3 broad categories.

(A) Short-day plants.

(B) Long-day plants.

(C) Neutral plants.

Short-day plants

Some plants are said to have a short day photoperiodic response i.e. they flower after they are exposed to light on short days. e.g. in winter days they flower after they are exposed to light in winter. If such plants are exposed to sunlight for more than their required critical time i.e. for longer days (e.g. summer days), they do not flower and remain in the vegetative phase.

The mutant, Maryland Mammoth tobacco plants are the examples of short day plants.

Long-day plants

Some plants also exhibit long -day photoperiodism i.e. they flower only if they are exposed to light for long days (e.g. summer days). They do not flower if they are exposed to light for short days (for less then their required critical time).

Klebs, in 1913, experimented with flowering of semperoivum, whose normal flowering time is known to be in June. Klebs kept this plant in a green house in midwinters and exposed it to artificial light after the short winter day was over, to equate it to the normal exposure of the plant in long summer days and he found that he could induce flowering in the plant.

Spinach, Sugarbeet, Redish, Henkane, Wheat etc. are the examples of long day plants.

Neutral Plants

Some plants observed to have no photoperiodic response. i.e. they are not affected by the exposure of

the light. They are known to have a definite vegetative period after which they flower.

Tomato, Pea, Cucumber, Sunflower, Cotton etc. are the examples of day-neutral plants.

SECOND DOMAIN

PLANT CELL

As understood by the cell theory, given by Matthias Schlieden and Theodon Schwann, a cell is the basic structural and functional unit of life.

In unicellular plants, the cell is the complete life form in itself. It has got all the mechanism and carry out all the life activities. e.g. Algae.

In higher life forms i.e. in the multicellular plants the cell is the basic unit of life and a number of cells team up together to form a life form a plant.

The cell is not said to have a very defined task. The cell performs the function according to its

specialisation. e.g. a root cell is specialised to perform the function of absorption of water and mineral salts. Similarly the leaf cells are specialised to perform photosynthesis and respiration.

Although the cells perform different functions as per their specialising, on the unit level all the cells are almost alike. A cell is characterised by the presence of number of typical organelles in a defined boundary. This boundary is called cell wall and their typical organelles are nucleus and cytoplasmic structures like mitochondria, plastids, ribosomes, golgi apparatus, endoplasmic reticulation, etc.

CELL WALL

We can define cell wall to be a limiting boundary that envelopes various cellular organelles. It gives a protective cover to the protoplasmic structures. This cell wall is a little rigid in nature and therefore it provides mechanical support to the cells. It renders a definite shape to the plant cells and thus the plant structure. The other important functions involving cell wall are the absorption of water and minerals,

secretions, etc. It also give cells disease resistance or defence resistance against parasites. In return the protoplast takes care of the cell wall by producing the components used in the formation of the cell wall and reinforces it.

The main structural components of the cell wall is cellulose which is a polysaccharide consisting of a number of sugar molecules. Other components participating in cell wall are hemicelluloses, lignin, subernin, proteins, enzymes, etc.

In certain cases the cell wall is said to have multilayer cell wall, or double layer.

(A) Primary wall.

(B) Secondary wall.

MITOCHONDRIA

Mitochondria, which are pleomorphic in nature, are bounded by two unit membranes. These membranes

enclose an inner matrix. Numerous folds in the inner membrane project deep into the matrix. These folds appear connected with the inner membrane on the opposite side. The projecting folds of inner membrane are collectively called as Crisate. They contain phospholipids, the nucleic acid (DNA and RNA), the Krebs cycle enzymes, the cytochromes, various substitutes and other compounds of the electron transport system (ETS).

The mitochondria provides a major part of the cell usable energy. When the proteins, fats and carbohydrates oxidise (break down) in the cytoplasm under different processes, CO2, water and energy are liberated. Now most of the energy released is conserved in the form of high energy phosphate bonds. The most important compound in this concern is adenosine triphosphate (ATP). The advantage of storing energy in this compound is that it can be released and utilised quiet readily to drive the energy consuming reactions of the cell. Further, the mitochondria are determined by a double membrane.

Mitochondria are also observed to display a

unique quality, to divide and grow somewhat independently of the nucleus although they cannot develope and survive on their own, independent of the nucleus.

GOLGI APPARATUS

The Golgi bodies or dictyosomes as they are often called appear in cross section as a bed of two distinct structures:-

A stack of five to fifteen flattened membrane-bound cisternae and several small spherical vessels that seem to group around the edges of the cisternae. This structure, collectively is called the Golgi apparatus. These vessels actually "punch off" from the surface of the form the surface of the cisternae membranes.

Studies have revealed that this system of membranes involved in different activities and processes. The vessels contain cell wall precursors (polysaccharides, proteins and other cellular chemicals). At the completion of mitosis they migrate towards the cell wall, cell plate

fuse with the plasmalemma and deposit their cell wall material in the plasmalemma-cell wall interface. It is thus observed that the Golgi bodies play an important role in cell wall formation.

RIBOSOMES

Ribosomes are essentially multimolecular aggregations of RNA and proteins. They are spheroidal and microscopic particles associated with the endoplasmic reticulum and found in the cytoplasm or in mitochondria and plastids. The RNA comprising in ribosomal structure is called ribosomal RNA (rRNA) while the coded RNA at the surface of the ribosome, involved in peptide synthesis or transition is called messenger RNA (mRNA). These ribosomes are usually found clustered or attached like beads on a string to mRNA. These clusters, called polyribosomes, are active primary sites of peptide synthesis. The biochemists often characterised ribosomes on the basis of their submit sedimentation.

THIRD DOMAIN

TEMPRARURE

It is a well established fact that almost all the plants have a definite photoresponse period.The growth and development of the plants depends upon the exposure of the plant for the critical photoperiod. on the other hand in certain plants, the photoperiod is observed to have no major effect or profound effect on the growth and devlopment of the plant. In this case the temprature plays the key role and defines the growth stage i.e. vegetative phase or reproductive phase etc. of the plant.

Henbane (Hyoscyamus nigor) is a good example in this case. For henbane to grow up and flower, cold temprature is very necessary. These flowers only after winters.

G.Melchers and A.Lang, in 1948, demonstrated the effect of temprature on henbane, its growth and flowering. It was observed that the plant flowered only

after winter treatment and when it received the required photoexposure.

The result of their experiment was:

	Irregular Photoexposure	**Critical Photoexposure**
Not subjected to cold	did not grow	did not grow
Subjected to cold	did not grow	grew and flowered

A term, vernalization, was also evolved in this concern. In simple word it can be defined as the process of giving temprature treatment to the plant.

Also in other words vernalisation can be defined as the subject of study of effects of temprature on the plants and their response to the same.

WATER (H_2O)

Water is essentially a compound of oxygen and hydrogen. The most important property of water with respect to the living cells is its solvent action. It it often referred to as universal solvent by the virtue of this property.. The solvent action of water is of tremendous importance for the living plants. The essential elements necessary for energy transfer and storage and the components of structural compounds, all require water as a translocaton and reaction medium. These materials are dissolved in water and distributed throughout the plant in this form. The process of Osmosis and imbition are intemately associated with the essential functions of the translocation of water and solutes site of origin to the site of acitvity.

OSMOSIS

This is the type of diffusion where the water is transported from one medium to the another through a semi-permeable or a differentially permeable membrane i.e. a membrane that allows diffusion on a selective basis, allowing certain specified substances to diffuse

through while prohibiting some. It is also observed that the flow of water or rather the diffusion of water is from an area of high concentration to the area of low concentration.

Osmotic pressure of a solution (water) is the pressure (it is the energy required to counter the energy depleted by the solution process) that would have to be applied to stop the diffusion of pure water into the solution under ideal osmotic conditions. This is often reffered to as osmotic potential.

The importance of osmotic potential is that it characterises a solution in several ways. It indicates the maximum pressure (osmotic pressure) that might develop if the solution were allowed to come to eqilibrium with pure water in an ideal osmotic system and it is proportionately related to the amount of solute in a solution and to the decrease in in chemical potential due to solvent-solute interactions.

IMBIBITON:

Imbibition is the type of diffusion which involves

adsorption action. In imbibition the water is adsorbed at the surface of the dry plant material, i.e. plant cell. Since the water is adsorbed at the surface of the relatively dry plant cell (high negative water potential) from a source of pure water (high water potential), the process of imbibition can be said to work on the principle of diffusion potential gradient which is similar to the concept involved in osmosis.

For imbibition to take place, a water potential gradient must exist between the surface of the adsorbent and the liquid imbibed and a certain affinity must exist between components of the adsorbent and the imbibed substance.

RADIATION

Radiation can be defined, broadly, as propagation of energy. Depending upon their nature and other physical properties, radiations can classified mainly as :

(A) Electromagnetic radiation

(B) Acoustic radiation

(C) Particle radiation

Electromagnetic radiations has got wide energy ranges. In normal energy range, the electromagnetic radiations display the characteristics of the wave phenomenon i.e. behaves like waves. Depending upon the wavelength of the radiation they are further subdivided as radio waves, microwaves, light (visible) radiation, ultraviolet, X-rays and Gamma rays.

Acoustic radiations or sound radiations as they are normally called, are broadly classified into three main categories, namely Infrasonic, sonic and Ultrasonic, on the basis of their frequency, in increasing order. The typical frequency range of sonic radiations is 16Hz-2000Hz.

The particle radiations normally propagating matter particles carrying high energy. Examples of particle radiations are alpha (~) particles, beta (B) particles, neutrons, cosmic rays, etc.

Effects Of Radiation

The radiations are classified into two main functional domains to study the effects of radiations on the biological systems.

(A) Ionising Radiations

(B) Non-ionising Radiations

The ionising radiations include highly energy electromagnetic radiations (X-rays, Gamma rays, Cosmic rays) and particle radiations (alpha particles, beta particles, neutrons). In these radiations the radiating particles carry very high energy which causes the ionisation of the targeted biological particles by knocking off electrons from their stable atoms and breaking the chemical bonds. Further, continuous over exposure to radiations causes chemical changes in some compounds. e.g. radiolysis of water produces chemically reactive substances (hydrobyl OH^- radical) which react with the cell or diffuse into the cell and brings about changes which at times is irreversible and damaging. Apart from these reactions some biological changes have

also been observed in the cells, or rather biological system of the organism. In this sense developing embryos are said to have maximum sensitivity towards radiation. In terms of effects of radiation the most important components to be affected are the plasma membrane and the DNA because they are present in the cells in singles and they carry the genetic information and are responsible for growth and development. It is therefore that over exposure renders them the biological death.

The non-ionising radiations are not as damaging as the ionising radiations for the reason that they do not have as much penetrating power as ionising radiations have. Among all kinds of non-ionising radiations those having substantial effect on the biological system are Ultraviolet, Microwaves and high voltage electromagnetic radiations.

The Ultraviolet violet radiations are of three kinds i.e. UV-A, UV-B, UV-C. Out of which most damage is done by UV-C. Biological abnormalities are observed often absorption in continous exposure. The absorption of ultraviolet radiations depends upon chemical bonds of

the target material and is very specific. Survival from the ultraviolet radiations reduces as the absorption is increased or the dose of radiations is increased.

Microwaves are electromagnetic radiations with the frequency range of 30MHz - 300MHz. Metals effect microwaves, glass transmits them and aqueous substances absorb them . Therefore materials with high water content have higher absorption coefficient of microwaves. These radiations are absorbed evenly in the biological tissue. Exposure to microwaves causes general heating of the biological system apart from other things. Also, the permeability of the cell membrane is greatly altered by the over exposure of microwaves.

It is important to note that despite all this, the process of photosynthesis is observed to be relatively insensitive to radiations. In general, the effect of radiations on the plants include mutation in the seeds and hampered or stalled growth and in some cases, the biological death.

CHAPTER 3

MATERIAL & METHODOLOGY

Ever since the evolution of life on earth, there has been a consistent growth of life forms. Mankind, the Homosapiens, have turned out to to be the smartest of all the life forms. They have been adapting themselves to the environmental conditions and more than that making the conditions suitable and favourable to themselves, using their intelligence. Todays mostly sophisticated world is the result of this intelligent thinking, on the part of man and his neverending thirst to explore new frontiers. To carry on our developmental studies, we need a database or a knowledge base giving us the details of the developments and work done previously on a given subject. This knowledge gives us an understanding of the subjects and works as a tool for further developments and studies. To keep pace with the developments we need a subject to manage this fast growing database which should also provide us with an easy access to the desired information. The science of BIBLOMETRICS were evolved for this purpose.

The science of Bibliometrics is essentially a mathematical technique, or rather application of

mathematical techniques on books and other forms of printed informative documents. It is applied to find out the core journal in a specific field. Also it gives us the information about the advancements in that area in different countries of the world, contribution of scientific authors, etc.

OBJECTIVES

Objectives of bibliometric studies are :

- To identify the core journal.
- To determine the ranking of authors.
- To determine the authorship patterns in the given literature.
- To identify the most popular language.
- To determine the ranking of institutions.
- To determine the yesr wise productivity of the given literature.

Selection of the topic:

To select a relevant topic to pursue our studies, certain factors such as availability of previous data, feasibility of the subject topic, scope and development

and applications, etc. are considered, we also take care that the topic bears relevance for the generations to come and further the scope of development.

Secondary sources such as abstracts are of great importance in this process. After going through Biological Abstract, Chemical Abstract, Physicas Abstract, etc. it was observed that the biological abstracts consisted of the largest database which has faesable and had some yet to be explored topics. Plant physiology one such topic. Since this was a very vast subject a more specific topic was needed. As of date , the hottest and the most debated topic over the globe was "Neuclearisation of the world and its effects". The nuclear effect is understood in terms of effects of nuclear radiation. Hence, this topic "Effects of Radiations on Plant Physiology".

Reference Cards:

After ascertaining the topic, some data is required to help us analyse the subject. Reference cards are made for this purpose. It is a card of size 3"x5". It

carries information about the author, title, name of journal, etc. A sample reference card is as under-

BALLARE (Caulosl), BARNES (Paul w), FLINT (stephan d), PRICE (Steven).
Inhibition of Hypocotyl Elongation by Ultraviolet-B radiation in de-etiolating tomato seedlings. II Time Course, comparison with Flavonoid Responses and adaptive significance.
Physiologia Plantarum 93(4):593-601.1995(IFEVA Dep. Ecol., Agronomia Univ. Buenos Aires, AV. San Martin, Buenos Aires, Argentina
English

Bibliometric Analysis:

Data related to this subject was collected published in the recent five years i.e. 1994-98. This data is the form of reference cards was converted to an analytical data through different analysis-tables. To understand the analysis in a better way the data from these analytical tables has been given graphical representation i.e. graphs.

Ranking of Author:

To determine the rank of authors yearwise table was formulated indicating the contribution of authors in the journals published. Later a more comprehensive table was formulated indicating the contribution of the authors to the subject field over the span of five years, i.e. 1994-98 and overall rank of the author was determined.

Identification of core journal:

To identify the core journal, they were arranged in decreasing order of productivity for a given year. After that their consistency was compared for the given year time span. Depending upon this comparative study and comprehensive analysis, a table was formulated indicating the overall productivity of the journals over the stretch of five years i.e. 1994-98.

Identification of Authorship Pattern:

After the formulation of the tables indicating the contribution of authors to the subject in the form of journals. The data was further analysed to observe the indirect contribution of authors by assisting in journals and appearing as second third etc. author. Conversly it was also observed if the particular author appered as a singe author or as a multiple author.

Identification of most popular language:

For this purpose the journals were grouped on the basis of their language of publication irrespctive of the author or the country of origin. Here also a table was formed indicating the total number of journals published in different languages over a span of five years i.e. 1994-98.

Ranking of Institutions:

The number of journals published on the subject by

different institutes across the globe were observed this observation was transcribed into analytical data and the comparative tables wre formulated for each year. After that a comprehensive table was formed indicating the number of journals published by different institutes concerning the subject over the span of five years i.e. 1994-98. And in this manner the ranking of different institutions was detrmined.

Year wise productivity:

To determine the year wise productivity the comprehensive table was formulated for each year to find out which year has given maximum references.

CITATION ANALYSIS

It concerns analysing the references that are cited most in aparticular article. For carrying out the citation analysis the reference cards are made for the references that are cited with the original article. As an average 45 to 45 references are cited with every original

article. Owing to a large number of level 1 reference cards (1090) only 10% of these cards were considered in citation analysis which is a level 2 analysis. After the citation cards were made the data collected was converted into analytical data through analysis table. These analysis tables were used to find out:

1- Ranking of cited authors

2- Ranking of cited journals

3- Most popular form of documents

4- Cited year.

TERAMURA (AH)

Effect of ultraviolet - B ----------

Physiologia Plantarum

1983

CHAPTER 4

The first level of analysis is done to find out the most productive journal, the most productive author, the most popular language, the country which has produced most of the artices and the most productive institute.

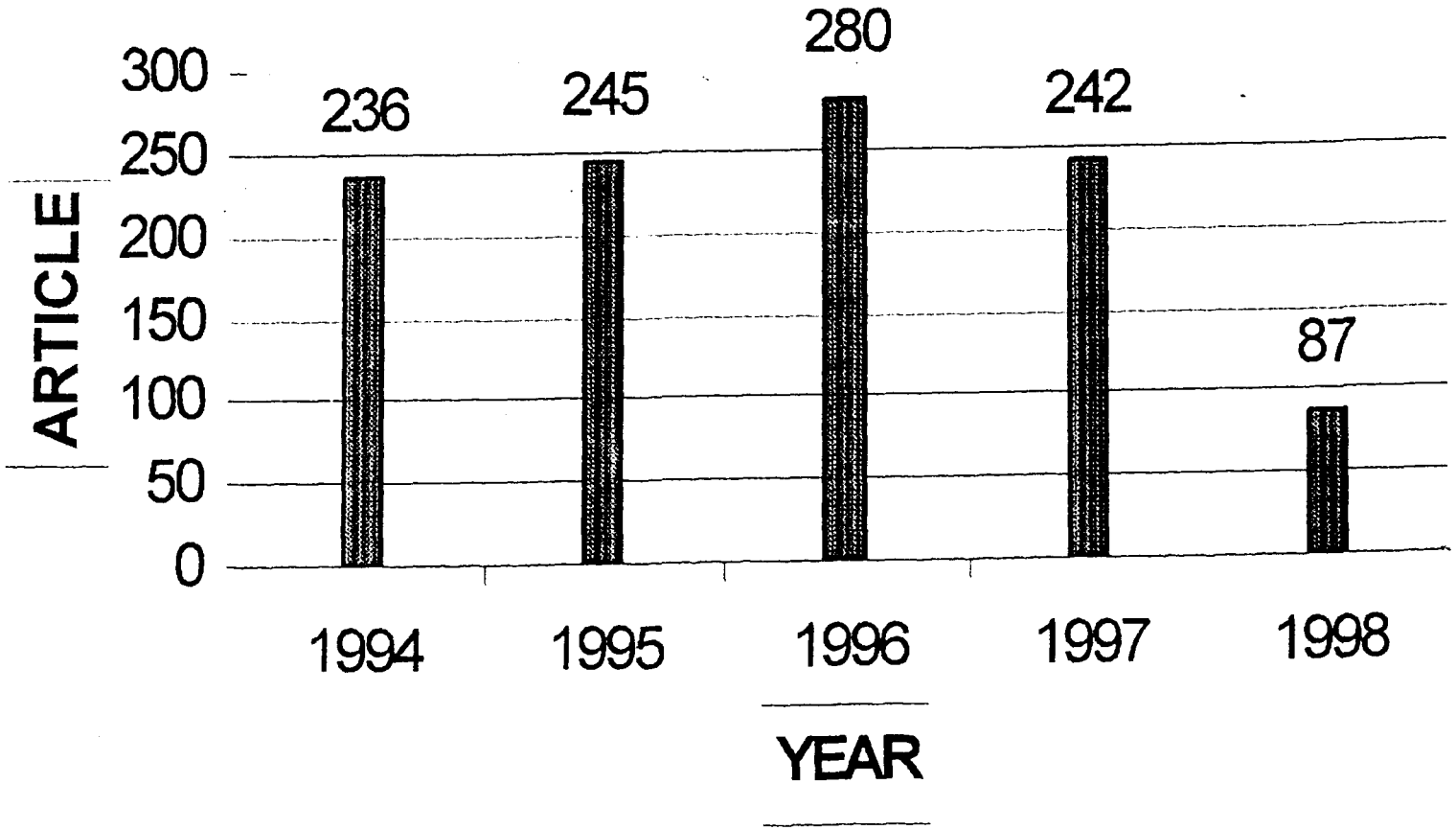
The first level of analysis is done to find out the most productive journal, the most productive author, the most popular language, the country which has produced most of the artices and the most productive institute.

YEAR WISE DISTRIBUTION OF PAPERS

The table 1-1 shows the year wise distribution of papers published during the last five years i.e. 1994-98. According to the table it can be observed that maximum number of articles were published in 1996 constituting 25.69% of the total publication of 1090 articles. The second most productive year is found to be 1995 having 22.48%, then comes year 1997 having 22.20% and then 1994 having 21.65%. The minimum number of articles appeared in 1998 having only 9.78% because of the fact that the secondary sources consulted did not have the complete reference of 1998. The graphical representation of the data is given in the table 1-1.

Year	Article	%age
1994	236	21.64
1995	245	22.48
1996	280	25.69
1997	242	22.2
1998	87	9.78
Total	**1090**	**100%**

TABLE 1-1
YEAR-WISE DISTRIBUTION OF THE PAPERS



JOURNAL WISE DISTRIBUTION

The table 2.1 indicates the total number of journals published on the subject of "Plant Physiology" and number of articles published by each journal on the subject from year 1994-1998.

A total of 183 journals were published material on the subject. The journal "Physiologia Plantarum" published the articles most consistently, totalling 94 articles out of 1090 articles. The second most consistent journal was "Plant Physiology (Rockville) with 64 articles and third was "Journal of Plant Physiology" with 61 articles.

TABLE 2
RANK LIST OF JOURNALS

S.No.	RANK	JOURNALS	94	95	96	97	98	TOTAL	PERCENT
1	1	Physiologia Plantarum	28	20	21	20	5	94	9.29
2	2	Plant Physiology (Rockville)	14	14	8	18	10	64	6.33
3	3	Journal of Plant Physiology	11	19	21	6	44	61	6.03
4	4	Photochemistry and Photobiology	9	10	17	10	5	51	5.04
5	5	Planta (Heidelberg)	10	13	12	6	-	41	4.05
6	5	Plant Cell and Environment	11	7	11	9	3	41	4.05
7	6	Journal of Photochemistry and Photobiology & Biology	7	11	3	14	5	40	3.95
8	7	Journal of Experimental Botany	7	8	6	12	5	38	3.48
9	8	Plant and Cell Physiology	7	7	5	7	4	30	2.75
10	9	Scientia Malina	-	2	19	3	-	24	2.20
11	10	Environmental and Experimental Botany	3	7	2	4	3	19	1.73
12	11	Australian Journal of Plant Physiology	4	3	1	5	4	17	1.68

S.No.	RANK	JOURNALS	94	95	96	97	98	TOTAL	%
13	12	Plant Journal	1	1	6	4	4	16	1.58
14	13	American Journal of Botany	4	5	4	2	-	15	1.48
15	13	Agricultural and Forest Meterology	3	2	3	5	2	15	1.48
16	14	Tree Physiology	1	2	5	4	2	14	1.38
17	15	Journal of Physiology	3	3	4	3	-	13	1.28
18	16	Journal of Plant Research	2	-	2	8	-	12	1.8
19	17	Botanica Acta	-	4	1	5	1	11	1.08
20	18	Acta Phytophysiologia Sinica	1	1	1	2	5	10	0.98
21	18	Photosynthesis (Praque)	2	1	1	3	3	10	0.98
22	18	Radiatsionnaya Boilogiya Radioekologiya	5	-	-	5	-	10	0.98
23	19	Canadian Journal of Botany	2	2	2	3	-	9	0.89
24	20	Annals of Botany	2	1	-	4	1	8	0.79
25	20	Biologia Plantarum (Prague)	1	-	3	3	1	8	0.79
26	20	New Physiologist	1	-	2	4	1	8	0.79
27	20	Photochemistry (Oxford)	2	-	-	3	3	8	0.79

RANK		JOURNALS	94	95	96	97	98	TOTAL	%
28	20	Plant Cell Tissue and Organ Culture	-	3	3	2	-	8	0.79
29	21	Dopovidi Akademyi Nauk Ukrainy	4	1	1	1	-	7	0.69
30	21	Plant Cell	1	4	1	-	1	7	0.69
31	21	Planta (Berlin)					7	7	0.69
		5 Journals have 6 Articles each							
		2 Journals have 5 Articles each							
		12 Journals have 4 Articles each							
		19 Journals have 3 Articles each							
		28 Journals have 2 Articles each							
		107 Journals have 1 Articles each							
							TOTAL	1090	100%

AUTHOR WISE DISTRIBUTION

The table 3-1 shows the contribution of the authors on the given subject. The author who contributed most and ranked first is J.J CASAL with 13 articles. The second position is taken by G. DOEHLER with 12 articles. B. THOMAS is on the third position with 9 articles.

S.No.	RANK	AUTHOR	ARTICLES
1	1	CASAL (J J)	13
2	2	DOEHLER (G)	12
3	3	THOMAS (B)	9
4	4	MANETAS (Y)	8
5	4	WHITELAM (GC)	8
6	5	JORDAN (BR)	7
7	5	QUAIL (Peter H)	7
8	5	RUEDIGER (Wolfhart)	7
9	5	SANCHEZ (Rodolf A)	7
10	5	SCHAEFER (Ebuhard)	7

6 Authors contributing 6 articles each.

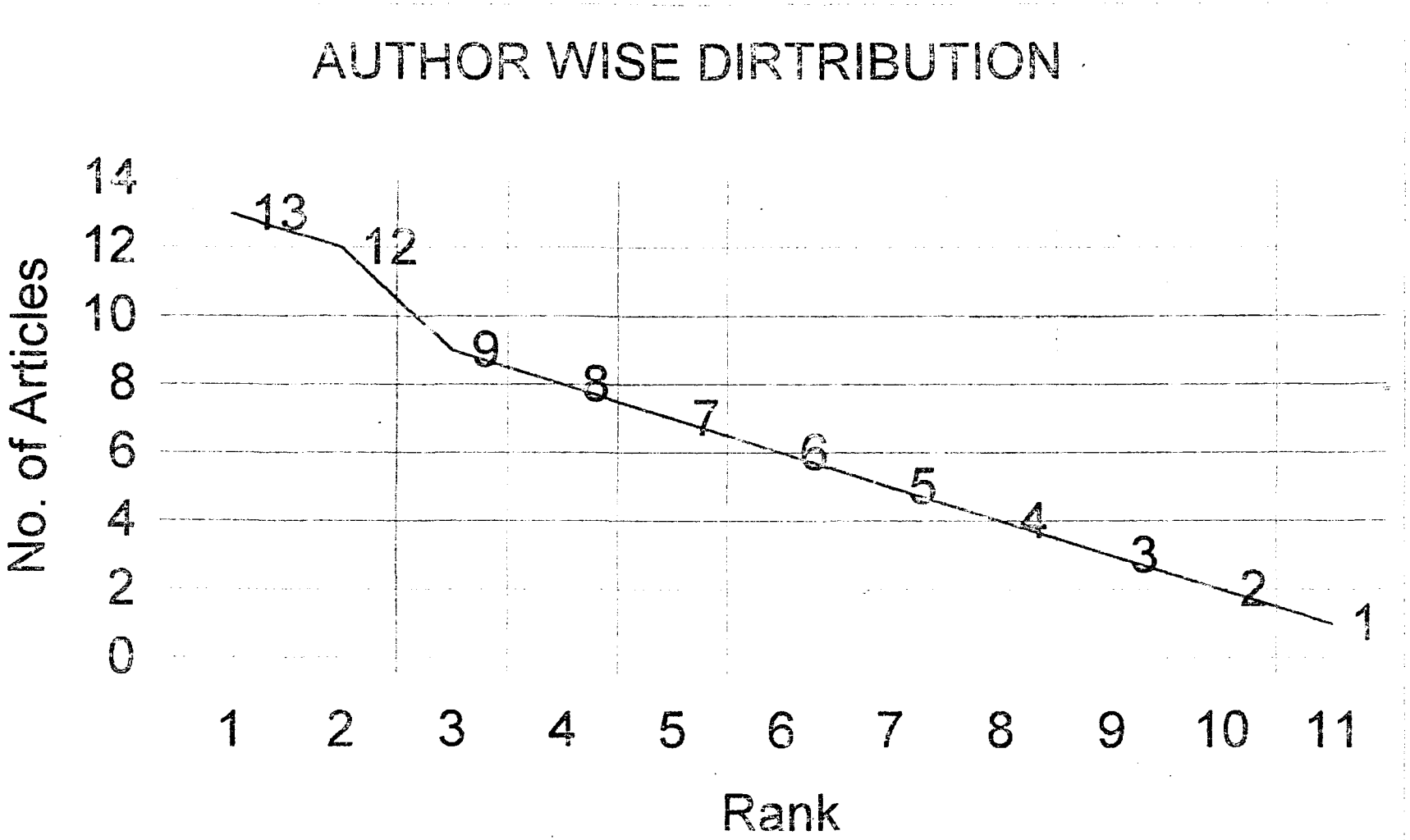
5 Authors contributing 11 articles each.

4 Authors contributing 25 articles each.

3 Authors contributing 75 articles each.

2 Authors contributing 219 articles each.

1 Authors contributing 1982 articles each.


AUTHOR WISE DIRTRIBUTION
No. of Articles
14
12
10
8
6
4
2
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13
12
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8
9
10
11
Rank

TABLE 4-1
AUTHORSHIP PATTERN

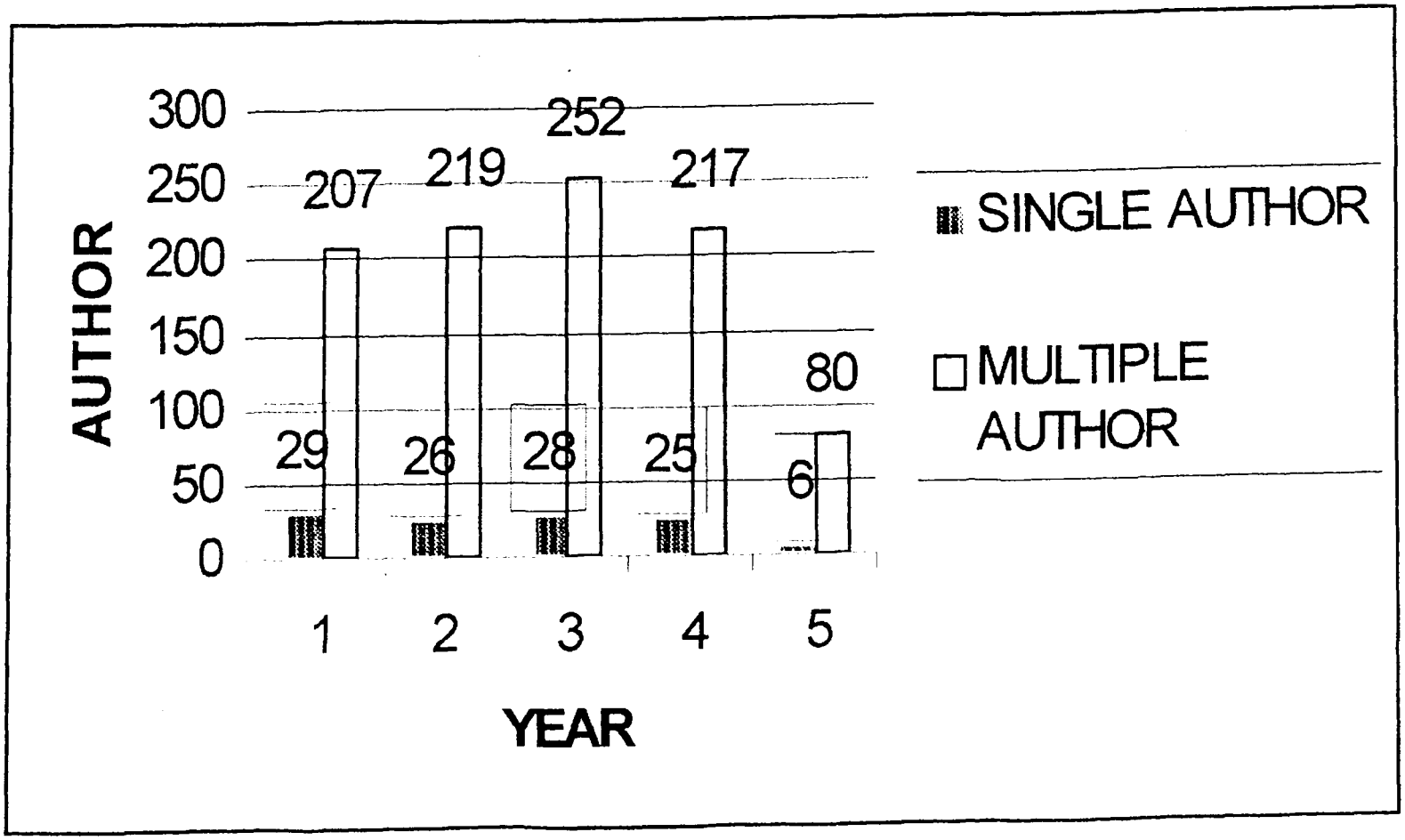
S.No.	YEAR	SINGLE AUTHOR	PERCENT	MULTIPLE AUTHOR
1	1994	29	25.44%	207
2	1995	26	22.81%	219
3	1996	28	24.56%	252
4	1997	25	21.93%	217
5	1998	6	5.26%	80
	TOTAL	114		975

AUTHORSHIP PATTERN

The table 4-1 shows the productivity of authors. It is found that multiple authorship is more than the singe authorship. Only 114 papers were found to have single authorship that of the 1090 articles examined. The remaining articles were contributed by multiple authors. The most productive year in which single authorship occurred is 1994, 29 single author with 25.44%. The most productive year in which the multiple authorship occurred is 1996, 252 multiple authors with 25.44%. The minimum productivity of single author is in 1998, 6 with 5.26% and the minimum productivity of multiple authors is 1998, 80 with 8.20%.

The graphical representation of the productivity of author is shown in table 4.

TABLE 4-1
AUTHORSHIP PATTERN



COUNTRY WISE DISTRIBUTION

The table 5 shows the contribution of different countries in terms of papers published on the given subject, over a span of 5 years i.e. from 1994-98.

It has been observed that out of 59 countries working on the subject, U.S.A. ranked first in publishing articles on the given subject, publishing a total of 197 articles from year 1994 to year 1998, amounting to 18.53% of the total number of articles published in 5 years. Germany reached second, publishing 139 articles amounting 13.08%. Further, the contribution by Japan, U.K., India, Russia was 10.35%, 5.64% and 5.27% respectively.

Geographical distribution in the graphical form is given in table 5-1.

RANK LIST OF COUNTRIES

S.No.	RANK	COUNTRIES	94	95	96	97	98	TOTAL	PERCENT
1	1	U.S.A.	47	45	56	40	9	197	18.53
2	2	GERMANY	29	32	34	35	9	139	13.08
3	3	JAPAN	19	22	30	28	4	110	10.35
4	4	U.K.	10	7	17	19	7	60	5.64
5	4	INDIA	16	18	12	9	5	60	5.64
6	5	RUSSIA	15	11	18	9	3	56	5.27
7	6	CANADA	5	8	8	10	1	32	3.01
8	7	ITALY	11	4	6	9	1	31	2.92
9	8	SPAIN	7	7	12	1	1	28	2.63
10	9	SWEDEN	8	3	8	5	3	27	2.54
11	10	ARGENTINA	5	10	4	4	3	26	2.44
12	10	AUSTRALIA	6	6	4	8	2	26	2.44
13	10	FRANCE	9	3	6	8		26	2.44
14	11	NETHERLAND	3	9	8	4	1	25	235

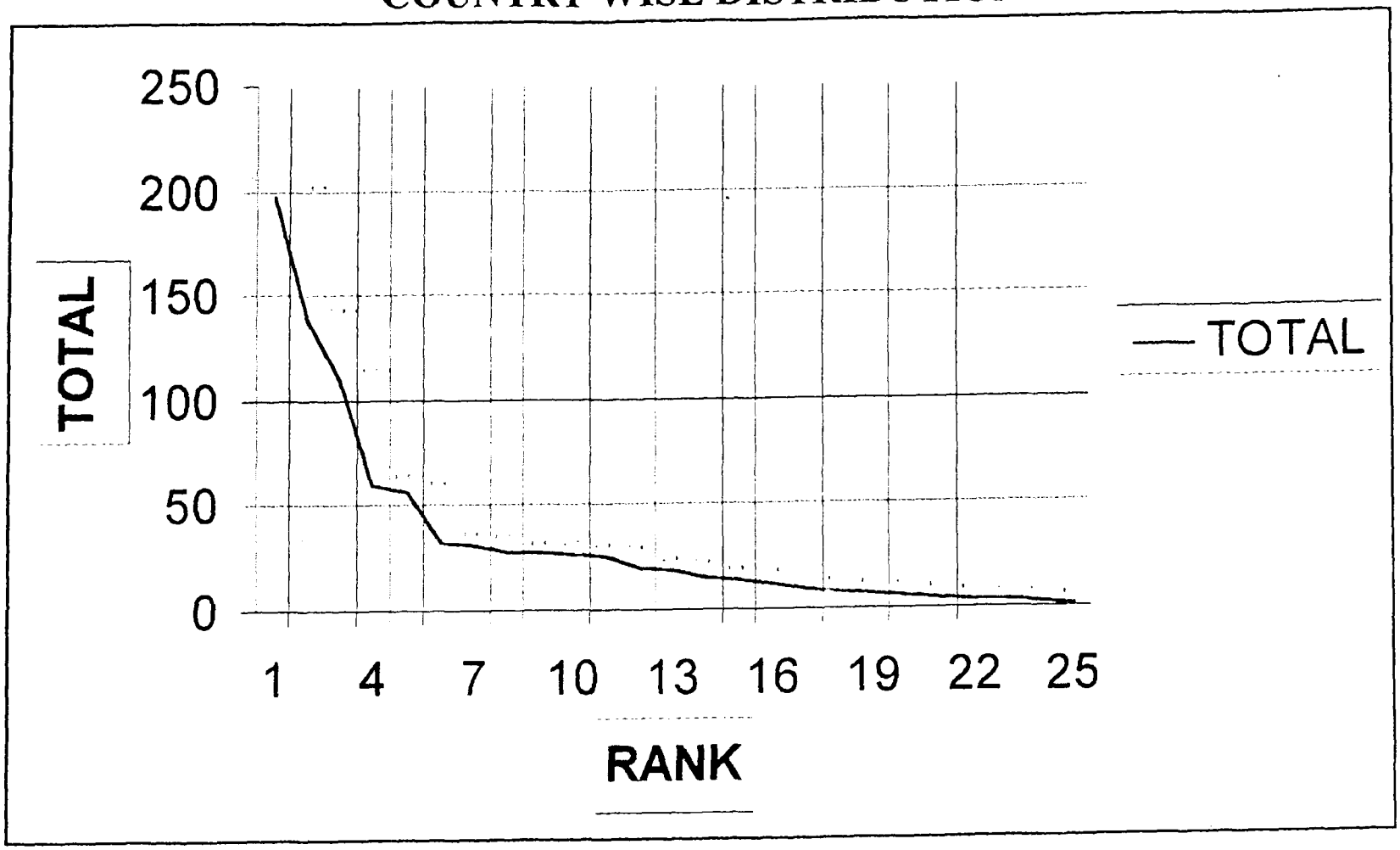
S.No.	RANK	COUNTRIES	94	95	96	97	98	TOTAL	PERCENT
15	12	CHINA	2	3	4	7	4	20	1.88
16	13	ISRAEL	4	5	4	5		18	1.69
17	13	UKRAINE	7	4	4	3		18	1.69
18	14	GREECE	4	6	2	2	1	15	1.41
19	15	POLAND	3	5	2	4		14	1.31
20	16	BELGIUM	2	2	1	5	1	11	1.03
21	17	NORWAY	2	3	1	2	1	9	0.84
22	18	BRAZIL	1	3	2	2		8	0.75
23	18	HUNGARY	1		3	3	1	8	0.75
24	18	SOUTH KOREA		3	3		2	1	0.75
25	19	BULGARIA	2	2		2	1	7	0.65
26	19	FINLAND	1		2	3	1	7	0.65
27	19	NEW ZEALAND	1	1	1	1	3	7	0.65
28	20	CZECH REPUBLIC	1		2	2	1	6	0.56
29	21	ESTONIA		1	2	1	1	5	0.47

S.No.	RANK	COUNTRIES	94	95	96	97	98	TOTAL	PERCENT
30	21	SOUTH AFRICA	2	1		1	1	5	0.47
31	22	PHILIPPINES	1	1	1	1		4	0.37
32	22	TAIWAN	1	1	2			4	0.37
33	23	DENMARK	1			2		3	0.28
34	23	MALAYSIA		1		2		3	0.28
35	23	LATVIA			3			3	0.28
36	23	SLOVENIA		2	1			3	0.28
37	23	EGYPT	2	1		1		3	0.28
38	24	AZERBIJAN		1		1		2	0.18
39	24	SWITZERLAND	1					2	0.18
40	24	BELARUS		1	1			2	0.18
41	24	PAKISTAN			2			2	0.18
42	24	PORTUGAL			1		1	2	0.18
43	24	SCOVAKIA	1	1				2	0.18
45	24	NIGERIA	2					2	0.18

S.No.	RANK	COUNTRIES	94	95	96	97	98	TOTAL	PERCENT
46	24	ROMANIA	2					2	0.18
47	24	YUGOSLAVIA	1		1			2	0.18
48	25	BANGLADESH				1		1	0.09
49	25	CROTIA				1		1	0.09
50	25	LITHUANIA			1			1	0.09
51	25	PANAMA			1			1	0.09
52	25	SINGAPORE			1			1	0.09
53	25	IRELAND		1				1	0.09
54	25	RICO		1				1	0.09
55	25	TURKEY		1				1	0.09
56	25	VENEZUELA		1				1	0.09
57	25	CHILE			1			1	0.09
58	25	MALDOVA	1					1	0.09
59	25	QATAR	1					1	0.09
	25	SYRIA					1	1	0.09

TOTAL = 1090 100%

TABLE 5-1
COUNTRY WISE DISTRIBUTION



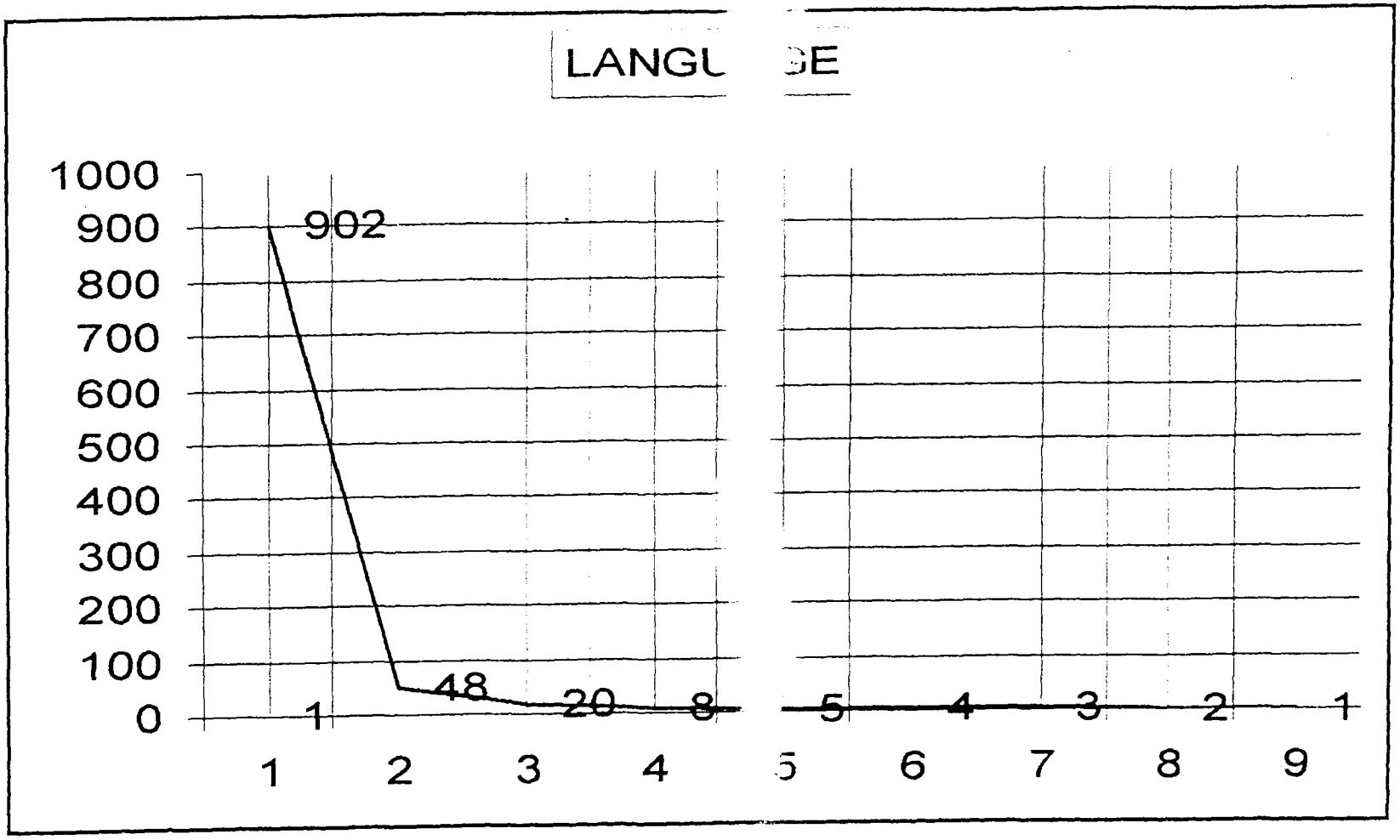
LANGUAGES WISE DISTRIBUTION

The table-6 shows the articles published in different languages on the given subject from year 1994 to year 1998.

Maximum number of articles were published in English i.e. 902 out of the total articles, amounting a whopping 90.56%. Also, 48 (4.82%), 20 (2.01%) and 8 (0.80%) articles were published in Russia, Chinese and Japanese languages respectively. The graphical representation of the languages is given in Table-6-1.

RANK	LANGUAGE	94	95	96	97	98	TOTAL	PERCENT
1	ENGLISH	112	224	255	230	81	902	90.56
2	RUSSIAN	21	5	14	7	1	48	4.28
3	CHINESE	1	3	5	6	5	20	2.01
4	JAPANESE	1	1	3	3		8	0.8
5	POLISH	1	2	1	1		5	0.5
6	GERMAN	2	2				4	0.4
7	UKRANIAN	1	1		1		3	0.3
8	PORTUGESE		1	1			2	0.2
9	BULGARIAN		1				1	0.1
9	SPANISH		1				1	0.1
9	ROMANIA	1					1	0.1
9	CZECH	1					1	0.1
						TOTAL	996	

TABL 5-1


LANGU GE
1000
900
800
700
600
500
400
300
200
100
0
902
48
20
8
5
4
3
2
1
1
2
3
4
5
6
7
8
9

INSTITUTE WISE DISTRIBUTION

The table-7 indicates the contribution of different institutes around the world on the subject of Plant Physiology.

It was observed that Dept. of Ecol. Fac.Agroronia Univ., Buenos Aires, B. A. Argentina carried most productive work on this subject by publishing 22 articles. Second most productive contribution was from Univ. of Germany, Tokyo Metropolitan Univ. of Japan and USDA- Agriculture Research Centre (Beltsvilla) of U.S.A. with 12 articles each. Institute Fuer Biologie of Freiburg, Germany ranked third with 10 articles.

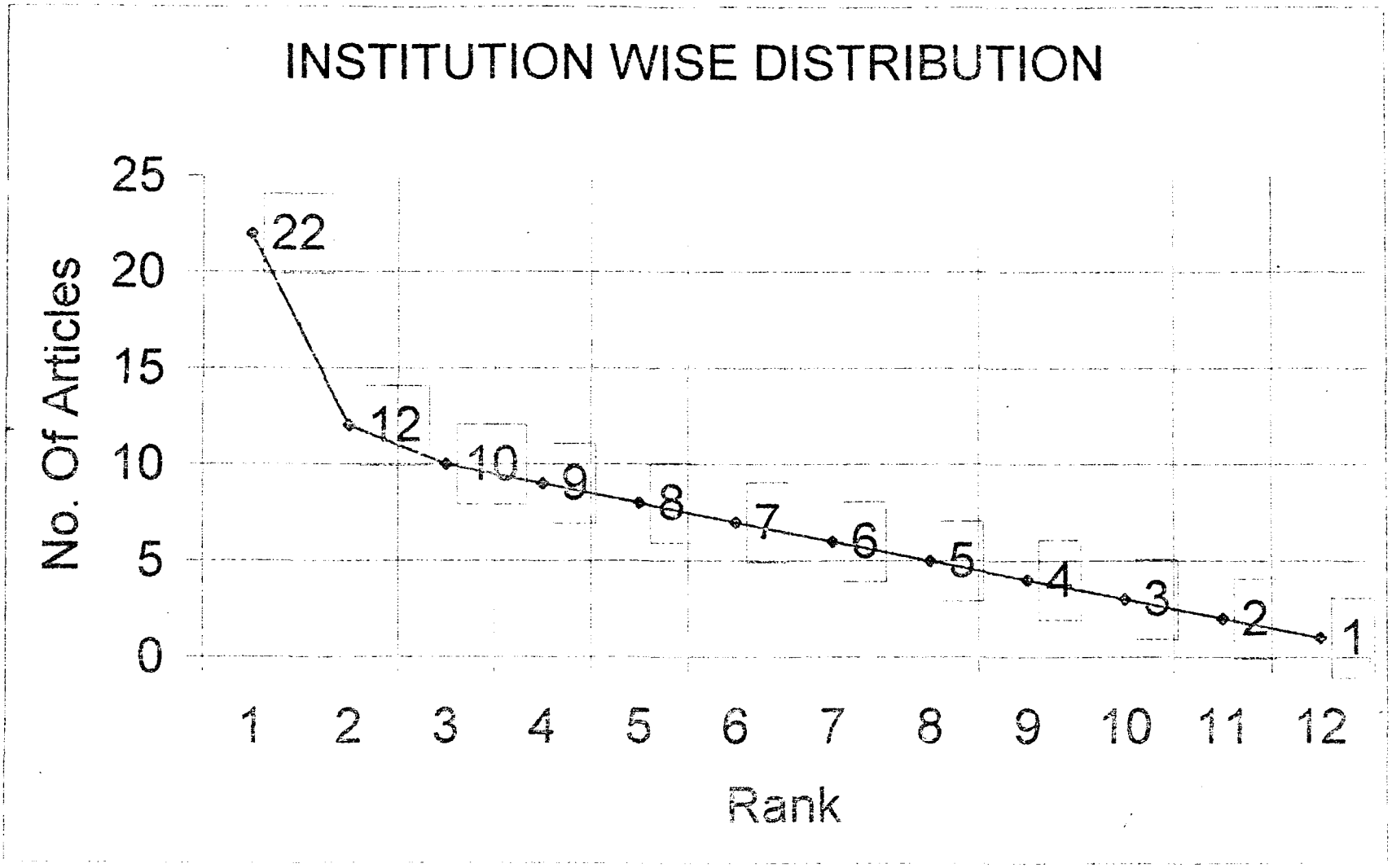
RANK LIST OF INSTITUTES

S.No	RANK	Name of Institutes	94	95	96	97	98	TOTAL	PERCENT
1	1	Dep. Ecol. Facultad Agronia Univ. Buenos Aires, B.A. ARGENTINA	4	9	4	3	2	22	2.10
2	2	Bost. Inst. Univ., Siesmayestr, Frankfurt, a.m. GERMANY.	-	5	1	3	3	12	1.15
3	2	Dep. Boil. Tokyo Metropolitan Univ., Miami Osawa, Hachioji-shi, Tokyo, JAPAN	4	3	-	2	3	12	1.15
4	2	USDA-ARS, Climate Stress Lab., Beltsville Agric. Res-cent, Baltmore ave, Beltville, U.S. A.	5	1	2	4	-	12	1.15
5	3	Inst. Fuer Biologie II, Schaenzlestr 1, Freiburg GERMANY.	3	1	2	3	1	10	0.95
6	4	K.A. Timiriazev Inst. Plant Physiol., Russian Acad. Sciences, Botanichestaya, Moscow, RUSSIA	2	1	5	1	-	9	0.86
7	4	Lab. Plant Physiology, Dep. Biology, Univ Patras GREECE.	1	5	1	1	1	9	0.86

S.No.	RANK	Name of Institutes	94	95	96	97	98	TOTAL	PERCENT
8	5	Fachburich Biol/Botanic, Phillips-Universitact Lahnberge, Marburg, GERMANY.	1	3	3	-	1	8	0.76
9	5	Bot. gardens, Fac. Sci., Osaka city Univ., Kisaichi Katunoshi, Osaka, JAPAN.	2	-	2	3	1	8	0.76
10	5	M.V. Lomonosov Mosco State Univ., Moscow, RUSSIA.	-	4	3	-	1	8	0.76
11	5	Inst. Cell. Biol. Genet. Eng. Natl. Acad. Sci. Ukr., Kiev UKRAINE.	2	1	3	2	-	8	0.78
12	5	Dep. Botany, Univ. Leicester, Leicester, U.K.	3	-	2	1	2	8	0.78
13	6	Inst. Botanic Pharm. Boil. Freidrich-Alexander Univ. Staudshrasse, Erlangen, GERMANY.	4	1	-	2	-	7	0.67
14	6	Bot. Inst., Univ. Muenchen, Menzinger Strasse, Munchen GERMANY.	-	1	1	3	2	7	0.67
15	6	Lab Photoreception signal Transduction, Frp, Riken Inst, Wako, Sailana, JAPAN.	-	1	3	2	1	7	0.67
	6	Horticulture Res. International, Wellsbourne, Walwic, U.K.	1	-	1	2	3	7	0.67

S.No.	RANK	Name of Institutes	94	95	96	97	98	TOTAL	PERCENT
16	7	Inst. Biol II Albeit-Uedwigs-Univ., Frieburg Schanenzlestrasse 1, Frieburg, GERMANY.	-	1	2	3	-	6	0.57
17	7	Plant Biophysics Lab. Inst. Life Sci., Hebrew Univ. Jerusalem, ISRAEL.	1	-	3	1	1	6	0.57
18	7	Inst. Genetics Ecol. Tohokli Univ, Sendai, JAPAN.	3	2	1	-	-	6	0.57
19	7	Dep. Plant Physiol. Wageninger Agric. Univ. Arborelumlaan Wageninger, NETHERLANDS.	1	-	2	1	2	6	0.57
20	7	Dep. Ecol. Fac. Ciencias Univ. Malaga, SPAIN.	-	3	1	2	-	6	0.57
21	7	Lund Univ., Sect. Plant Physiol., Lund, SWEDEN.	1	-	5	-	-	6	0.57
22	7	Sec. Mol. cellular Biology Univ., California, Davis, U.S.A.	-	2	3	-	1	6	0.57
23	8	Inst. Bot. Chinese Acad. Sci. Beijing, CHINA.	1	1	2	2	-	6	0.57
24	8	Deptartment d Ecophysiologic Vegetative et de Microbiologie, CEA-Cadrache, Saint-Paul-Lez-Dwance FRANCE.	-	-	2	3	-	5	0.47

S.No.	RANK	Name of Institutes	94	95	96	97	98	TOTAL	PERCENT
25	8	Dip. Biol. Piante Agrarie, Sezione Orchollva Floricollura Univ., Pisa, Pisa, ITALY.	2	1	-	2	-	5	0.47
26	8	All Russ. Res. Inst. Agrc. Radiol. Agroecol. Cbninsk RUSSIA.	1	1	2	1	-	5	0.47
27	8	Dep. Chem, Univ. Karlstad, Karlstad, SWEDEN.	-	1	3	1	-	5	0.47
28	8	Biol. Sci.Div. Inst. Environmental Bio. Sci., Lancaster Univ., Lanchaster, U.K.	4	-	1	-	-	5	0.47
29	8	Dep. Biol. Sci. Providue Univ., West Lafayette, U.K.	-	1	-	2	2	5	0.47
30	8	Dep. Bot., Univ. Maryland, College Park, MD, U.S.A.	-	1	1	2	1	5	0.47
		17 Institutes have 4 articles each. 47 Institutes have 3 articles each. 104 Institutes have 2 articles each. 389 Institutes have 1 articles each.							
								TOTAL = 1090/100%	


INSTITUTION WISE DISTRIBUTION
No. Of Articles
25
20
15
10
5
0
22
12
10
9
8
7
6
5
4
3
2
1
1 2 3 4 5 6 7 8 9 10 11 12
Rank

The 2nd level of analysis is done to find out the most cited author, the most productive Journal, the most popular form of the document, the number of citation in each year also the year in which the most citation appeared.

The collected data in the present study consisted of a total number 762 citations. The number of articles scanned were 31. I have took 10% form each from the total number of publication published in each year. We can observe that the maximum citations appeared in the year 1994, constituting 28.1%. The second most productive year in which the citations appeared was 1995, constituting 23.8%. Then 1996 constituting 20.9% and then 1997 constituting 14.4%. The minimum citations appeared in 1998 because of the fact that the secondary sources consulted didn't have the complete reference of 1998.

YEAR	ARTICLES	REFERENCES	PERCENT
1994	8	215	28.1%
1995	7	182	23.8%
1996	6	160	20.9%
1997	6	110	14.4%
1998	4	95	11.1%
TOTAL	31	762	100%

CITED AUTHOR

This table shows the productivity of the coted authors. The most productive author is A H TERAMURA, contributing 22 articles. The second most productive author is M.M CALDWELL contributing 20 papers. The third position is achieved by O W LEE contributing 11 papers.

AUTHORS	94	95	96	97	98	TOTAL
TERAMURA (AH)		6		10	6	22
CALDWELL (MM)			9		11	20
LEE (DW)		3	8			11
LILLO (C)	10					10
VERGARA (BS)		4	6			10
BJORN (LO)	1	3	2		3	9
MCCLURE (JW)	1	8				9
DAI (Q)		4	3		1	8
KOLLER (D)	6		2			8
PEARCY (RW)		1	6	1		8
SABATER (B)	8					8
FLINT (SD)			2		5	7
BJORKMAN (O)	1	4	2			7

Authors contributing 6 papers each = 6
Authors contributing 5 papers each = 12
Authors contributing 4 papers each = 30
Authors contributing 3 papers each = 41
Authors contributing 2 papers each = 127
Authors contributing 1 papers each = 951

CITED JOURNALS

The table-2 shows the list of cited journals. On the basis of the given subject it can be observed that the most cited journal was Journal of Plant Physiology constituting 103 articles from the total publication of 607 articles, constituting 16.96%. The second most cited journal is Physiologia Plantam having 57 citatons constituting 9.50%. The third productive journal is Planta having 32 articles with 5%. In the analysis at the level one the core journal was Physiologia Plantarum whereas at level 2 the core journal emerged as journal of Plant Physiology. This therefore shows that the position of core journals was not constant but varied in the two levels.

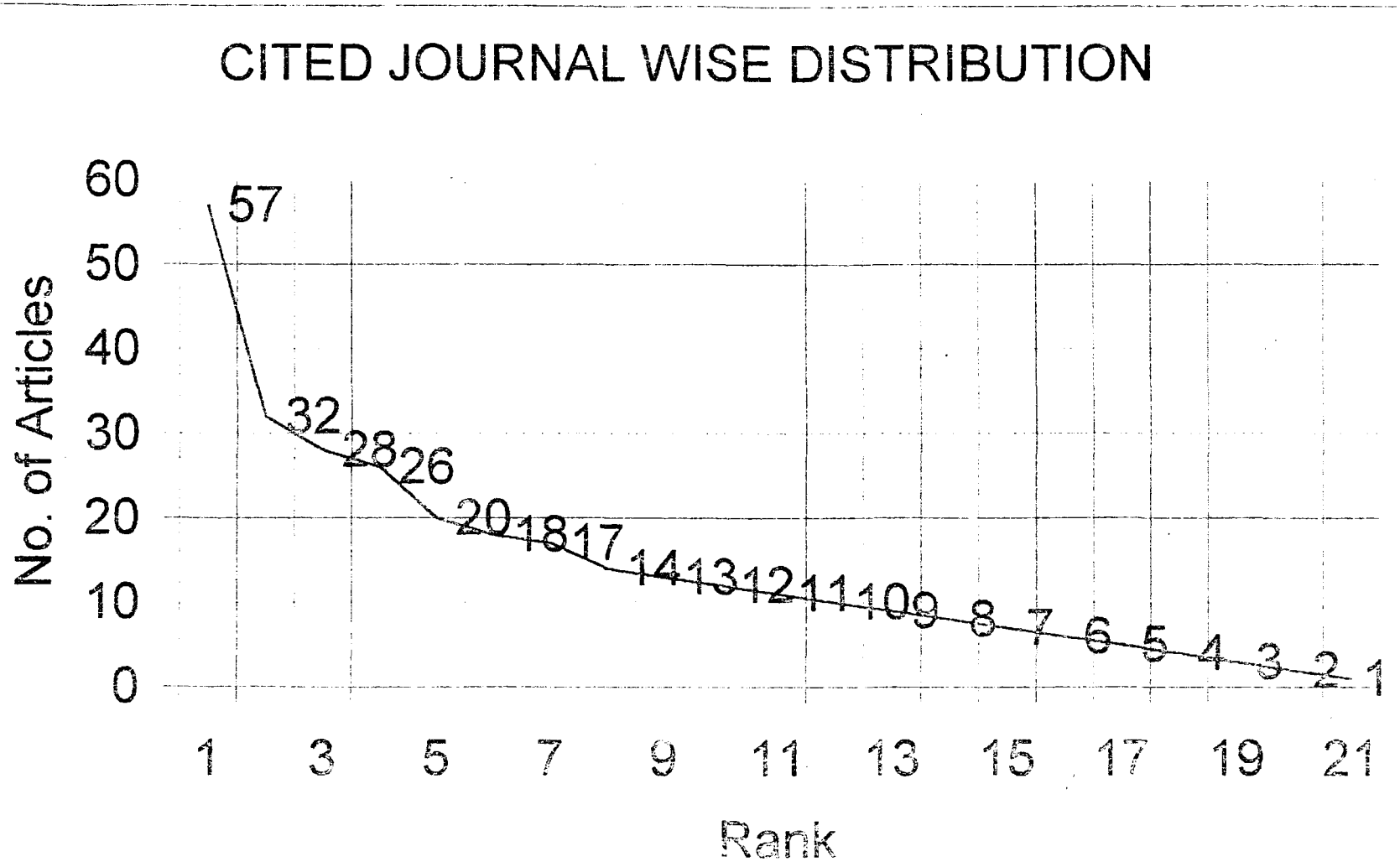
RANK LIST OF CITED JOURNALS

S.No.	RANK	JOURNALS	94	95	96	97	98	TOTAL	PERCENT
1	1	Journal of Plant Physiology	32	20	14	20	17	103	16.96
2	2	Physiologia Plantarum	18	15	4	6	14	57	9.39
3	3	Planta	6	7	3	7	9	32	5.27
4	4	American Journal of Botany	6	7	9	2	4	28	4.61
5	5	Photochemistry and Photobiology	12	4	5	3	2	26	4.28
6	6	Plant Cell and Environment	3	3	9	4	1	20	3.29
7	7	Oecologia	4	2	9	3	-	18	2.96
8	8	Journal of Experimental Botany	4	8	3	2	-	17	2.80
9	9	Science	2	2	5	3	2	14	2.30
10	10	Annual Review of Plant physiology & Molecular Biology	4	5	3	1	-	13	2.14
11	10	Annual Review of Plant Physiology	3	7	1	-	2	13	2.14
12	11	Environmental and Experimental Botany	1	3	5	-	3	12	1.97

S.No.	RANK	JOURNALS	94	95	96	97	98	TOTAL	%
13	12	Journal of Biological Chemistry	2		3	3	3	11	1.81
14	13	Proc. Nalt. Acad Sci.	1	1	4	2	2	10	1.64
15	13	Journal of Ecology	5	1	2	-	2	10	1.64
16	14	Phytochemistry	3	4	1	-	1	9	1.48
17	15	New Phyto	3	1	2	2	-	8	1.31
18	15	Journal of Biochemistry	-	1	3	4	-	8	1.31
19	15	Nature		2	2	3	1	8	1.31
20	16	Crop Science	3	-	3	1	-	7	1.16
21	17	Annals of Botany	3	2	--	-	1	6	0.98
22	18	Australian Journal of Plant Physiology		3	2	1	-	6	0.98
23	18	Botanical Gazette	3	1	1	-	-	5	0.82
24	18	Biochem Biophysics Aeta.	3	1	1	-	-	5	0.82
25	18	Functional Ecology	2	2	1	-	-	5	0.82
26	18	Anal. Biochem	1	2	-	1	1	5	0.82
27	18	Plant Cell	-	4	1	-	-	5	0.82

	RANK	JOURNALS	94	95	96	97	98	TOTAL	%
28	18	Journal of Environmental Quality	-	1	4	-	-	5	0.82
29	19	Cell	-	2	-	1	1	4	0.65
30	19	Ecological Memographs	-	2	2	-	-	4	0.65
31	20	Arch. Biochem. Biophys.	1	1	-	1	-	3	0.49
32	20	Journal of Physiology	2	-	1	-	-	3	0.49
33	20	Marine Biology	3	-	-	-	-	3	0.49
34	20	Molecular and general Genetics	1	1	1	-	-	3	0.49
35	20	Plant Science	2	1	-	-	-	3	0.49
36	20	International Journal of Biometeriology	-	1	2	-	-	3	0.49
37	20	Photosynthesis Research	-	3	-	-	-	3	0.49
38	20	AMBIO	-	-	1	-	2	3	0.49
39	20	Photosynthetica	-	-	2	-	1	3	0.49
40	20	Plant Molecular Biology	-	-	2	1	-	3	0.49
41	20	Journal of Genetics	-	-	-	3	-	3	0.49
42	21	Canadian Journal of Forestry Research	1	-	1	-	-	2	0.32

	RANK	JOURNALS	94	95	96	97	98	TOTAL	%
43	21	Rev. Esp. Fisiol.	2	-	-	-	-	2	0.32
44	21	Trends in Ecology and Evolution	1	-	-	-	1	2	0.32
45	21	Biological Reviews	-	1	1	-	-	2	0.32
46	21	Plant Physiology and Biochemistry	-	2	--	-	-	2	0.32
47	21	Revista Biologia Tropical	-	2	-	-	-	2	0.32
48	21	FEBS letters	-	-	2	-	-	2	0.32
49	21	Journal of General Physiology	-	-	2	-	-	2	0.32
50	21	Trees	-	-	2	-	-	2	0.32
51	21	Radiation Botany	-	-	-	2	-	2	0.32
52	21	Vegetation	-	-	-	-	2	2	0.32
53	21	Others					78		
		TOTAL						607	


CITED JOURNAL WISE DISTRIBUTION
No. of Articles
60
50
40
30
20
10
0
57
32
28
26
20
18
17
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1
3
5
7
9
11
13
15
17
19
21
Rank

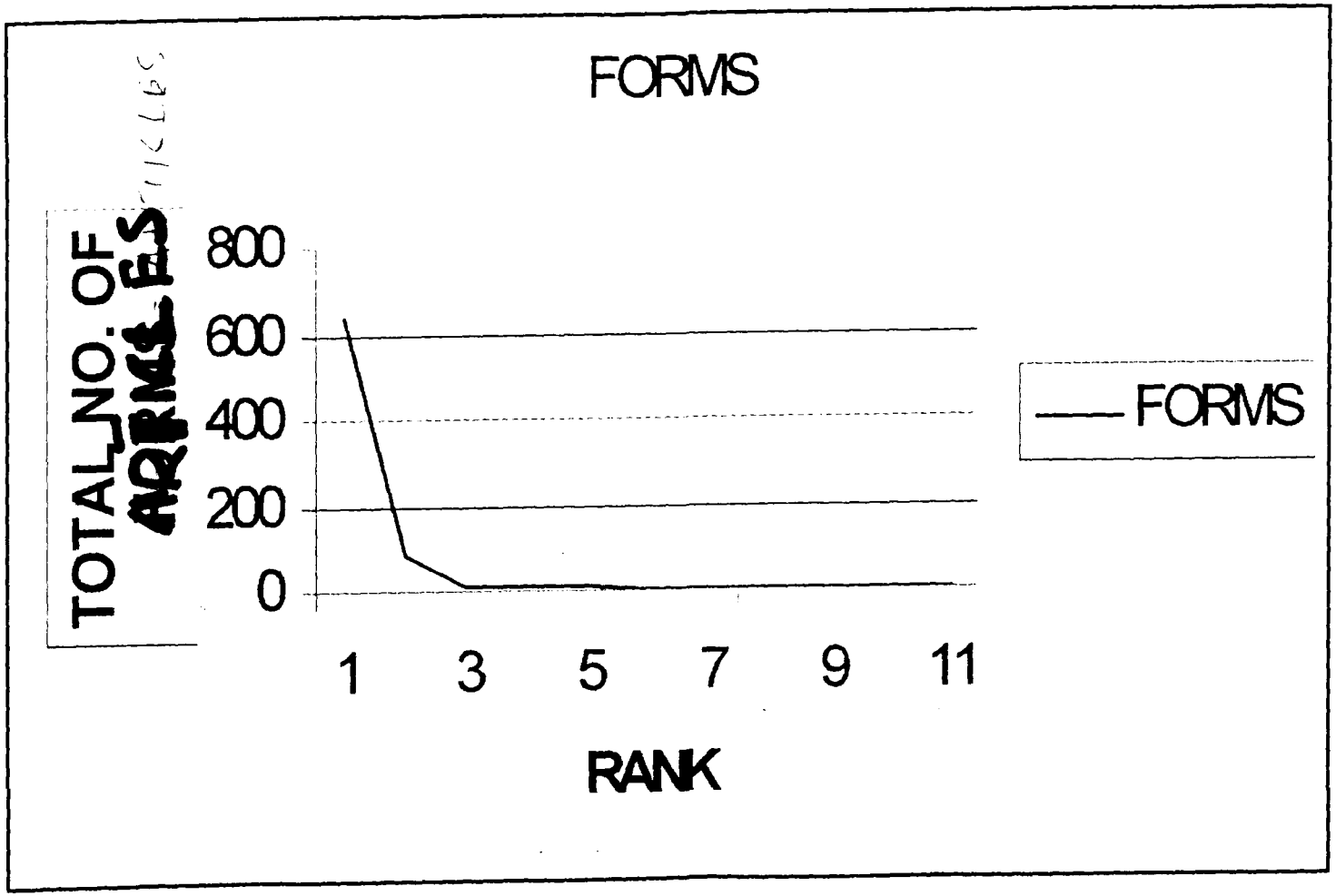
FORM WISE DISTRIBUTION

In the analysis of citations on the basis of its form, it has been found that a variety of documents are used in our this field study. The significant of document will observed like. Journal books, reports, conference Bulletins, thesis etc. The most popular form in which the articles appeared is the journals covering 636 articles with 83.90% of the total references. The second position is taken by the books covering 83 with 10.94% of the total references. The third position is taken by Proceecings having 9 title with 1.18%.

Table 3

RANK LIST OF FORMS OF DOCUMENTS

RANK	FORM	94	95	96	97	98	TOTAL	PERCENT
1	JOURNAL	169	143	153	87	84	636	83.90
2	BOOK	28	26	13	7	9	83	10.94
3	PROCEEDINGS	4	1	1	3		9	1.18
4	ENCYCLOPEDIA	2	4	1			7	0.92
5	THESIS	1	4	2			7	0.92
6	DEPT/INST.	4		1			5	0.65
7	REPORTS	3				1	4	0.52
8	BULLETIN	2		1			3	0.39
9	RESEARCH NOTES		2				2	0.26
10	REVIEW	1					1	0.13
11	ASSESMENTS					1	1	0.13
TOTAL		214	180	177	110	95	758	


FORMS
TOTAL NO. OF ARTICLES
800
600
400
200
0
1
3
5
7
9
11
RANK
FORMS

CITED YEARS

	94	95	96	97	98	TOTAL
1997				2	1	3
1996				5	3	8
1995		3	10	7	3	23
1994	1	19	12	6	6	44
1993	12	14	21	7	10	64
1992	20	14	11	8	5	58
1991	17	16	11	3	1	48
1990	21	12	17	12	7	69
1989	16	13	6	8	4	47
1988	11	5	2	4	9	31
1987	8	13	4	6	5	36
1986	9	12	9	5	5	40
1985	7	6	5	1	6	25
1984	9	10	5	1	4	29
1983	4	5	5	1	4	19
1982	4	3	2	1	1	11
1981	13	7	4		4	28
1980	7	4	3			14
1971-1979	29	21	17	13	9	89
1961-1970	15	4	9	8	5	41
1951-1960	3		2	67	2	14
1941-1950	2			2		4
1931-1940	3		3	1	1	8
1921-1938	2					2
1911-1920		1				1
						757

APPLICATIONS OF BIBLIOMETRIC LAWS

The Bibliometric study involves the following :

- Bradford's law of 'Scattering
- Lotka's inverse square law
- Zipf's law of word occurance

BRADFORDS LAW

The Bradford's law defines that if the scientific periodicals are arranged in order of decreasing productivity of articles on a given subject they may be divided into a nucleous of periodicals containing a large number of articles on the subject and several groups or zones of more journals containing the same number of articles.

Bradford's law was later on modified and refined by many persons such as Vickery who said that the multiplier need not be 5, the zones need not be 3, the multiplier can be less than five and we can and should have more than three zones for literature of various subjects. Gross found that the scatter of research papers among physics journals deviated from chart predicted by

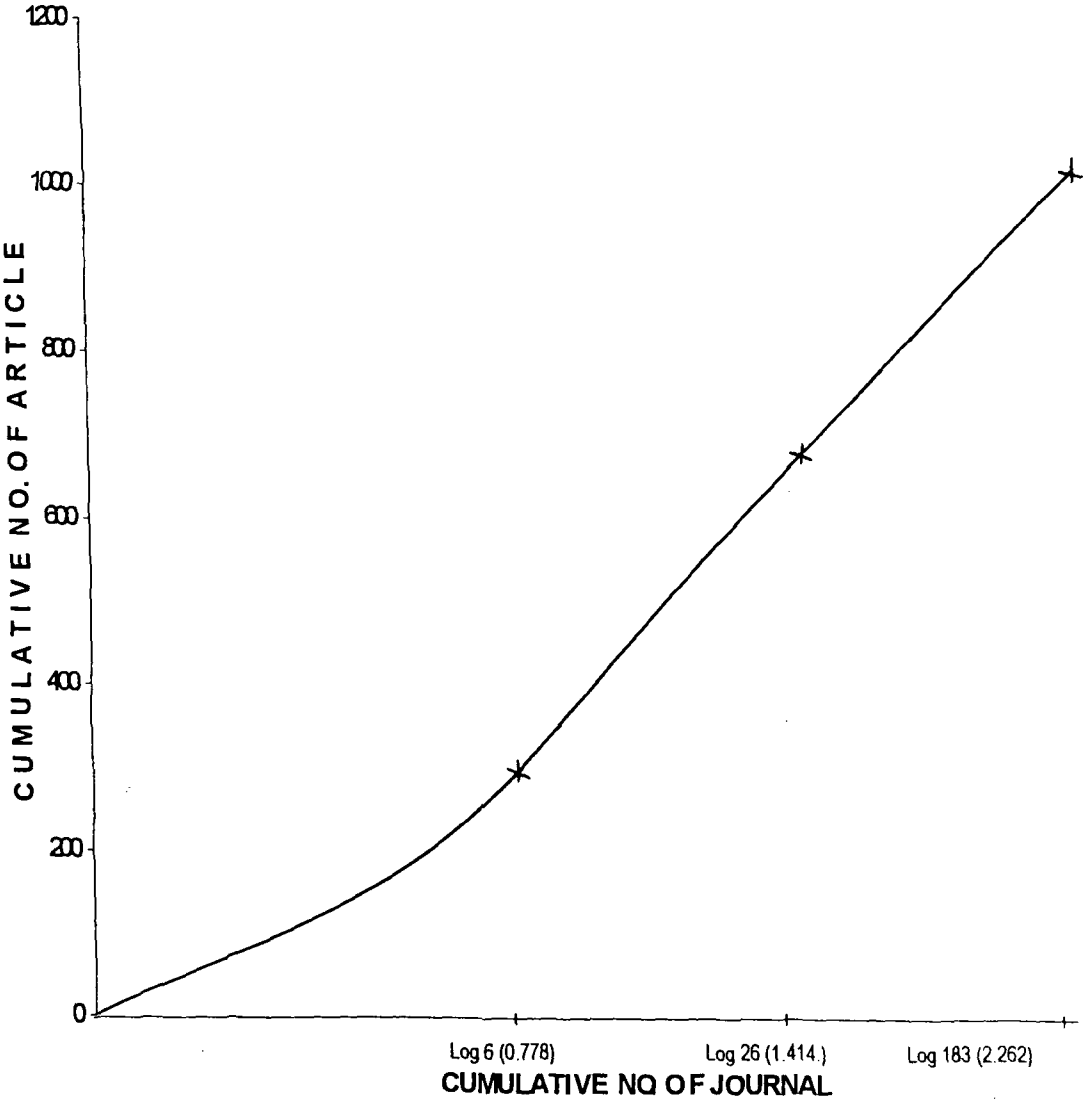
Bradford's law. Chonez tested a large number of different areas and found that the law applied in a very smali proportion of them. That of fifty bibliographies tested by him only six followed the law.

Bradford's law was applied, the three zones were

Zones	Journals	cumulative no. of Jouvnals	Articles	cumulalu no of articles
Zonel	6	6	352	352
Zone2	20	26	330	682
Zone3	157	183	328	1010

But the number of journals could not be worked out in the ratio of $1:n:n^2$, the number was 6 journals centre, 352 articles, 20 Journal containing 330 articles and the third zone have 157 journals with 328 articles. So specifically the law could not be proved, but it is proved broadly.

BRADFORD'S LAW



LOTKA INVERSE SQUARW LAW

Lotka's inverse square law correlate contributions of scientific papers to their number of contributions.

In Lotka's law also, it was found to fit the most cases. However, the value of the index 'n' was found to vary for different groups of scientists. Lotka's law was applied $1/n^2$. This law is not provide in total because of the fact that in recent years the multiple authorship has increased tremendously. Basically this law is applied where single authorship is involved.

According to the Authors analytical table

S.No.	Papers	Author
1	1	975
2	2	219
3	3	75
4	4	25
5	5	11
6	6	6
7	7	5
8	8	2
9	9	1
10	12	1
11	13	1

Lotka's Law

Author ~ $1/n^2$

n = number of papers of contribution

If the author contributing 2 papers = no. of authors contributing 1 paper/n^2

= $975/2^2$

= 975/2x2= 243

If the author contributing 3 papers = no. of authors contributing 1 paper/n^2

= $975/3^2$

= 975/3x3= 108

If the author contributing 4 papers = no. of authors contributing 1 paper/n^2

= $975/4^2$

= 975/4x4= 60

If the author contributing 5 papers = no. of authors contributing 1 paper/n^2

= $975/5^2$

= 975/5x5= 39

If the author contributing 6 papers = no. of authors contributing 1 paper/n^2

= $975/6^2$

= 975/6x6= 27

If the author contributing 7 papers = no. of authors

contributing 1 paper/n^2

$= 975/7^2$

$= 975/7x7 = 19$

If the author contributing 8 papers = no. of authors contributing 1 paper/n^2

$= 975/8^2$

$= 975/8x8 = 15$

If the author contributing 9 papers = no. of authors contributing 1 paper/n^2

$= 975/9^2$

$= 975/9x9 = 12$

These numbers vary because of the fact that the multiple authorship has increased tremendously.

DE SOLLA PRICE (Square root law of scientific productivity)

This law is applied on the literature of institutions, where the analysis satisfies the law.

From the total number of institutions available i.e. 589 institutions arranged in decreasing order of productivity, 20% i.e. 118 institutes were found to have produced 50% of the total literature.

CHAPTER 5

CONCLUSION

The qualitative analysis pertaining to books or documents is applied in this work. The whole analysis is done at two different levels.

In the first level the data is analysed to find out the yearwise distribution of the articles, the core journal, the most productive author, geographical distribution, the most popular language and the institutes which have contributed most. The yearwise distribution of articles is given below:

YEAR	ARTICLES	PERCENT
1994	236	21.64
1995	245	22.48
1996	280	25.69
1997	242	22.2
1998	87	9.87

The five most productive authors are given below:

S.No.	AUTHOR	ARTICLES
1	CASAL (JJ)	13
2	DOEHLER (G)	12
3	THOMAS (B)	9
4	MANETAS (Y)	8

The ranked list of journals is given below:

RANK	S.No.	JOURNALS	PERCENT
1	1	Physiologia Plantarum	9.29
2	2	Plant Physiology	6.33
3	3	Journal of Plant Physiology	6.03
4	4	Photochem. & Photoboilogy	5.04

Country wise distribution is given below:

RANK	S.No.	COUNTRIES	PERCENT
1	1	U.S.A.	18.53
2	2	GERMANY	13.08
3	3	JAPAN	10.35
4	4	U.K.	5.64

The most popular language used by the authors are given below:

RANK	S.No.	LANGUAGES	PERCENT
1	1	English	90.56
2	2	Russian	4.28
3	3	Chinese	2.01
4	4	Japanese	0.01

The most productive institutes are listed below:

RANK	INSTITUTE	PERCENT
1	Dep. Ecol. Facultad Agronia Univ. Buenos Aires, B.A. ARGENTINA	2.10
2	Bost. Inst. Univ., Siesmayestr, Frankfurt, a.m. GERMANY.	1.15
2	Dep. Boil. Tokyo Metropolitan Univ., Miami Osawa, Hachioji-shi, Tokyo, JAPAN	1.15
2	USDA-ARS, Climate Stress Lab., Beltsville Agric. Res-cent, Baltmore ave, Beltville, U.S. A.	1.15
3	Inst. Fuer Biologie II, Schaenzlestr 1, Freiburg GERMANY.	0.95
4	K.A. Timiriazev Inst. Plant Physiol., Russian Acad. Sciences, Botanichestaya, Moscow, RUSSIA	0.86
4	Lab. Plant Physiology, Dep. Biology, Univ Patras GREECE.	0.86

After the tables were analysed the Bibliometrics laws was applied on the literature. Like the Bradford's law was applied to find the core journals. It was proved broadly. Second, Lotka's law was applied to find the most productive authors. But it was not proved because of the increase of multiple authorship.

In the second level the analysis is done of the references attached to the source articles. Here also different types of analysis is done like the most cited authors, the most cited journals, the forms of documents of the cited articles, and the year in which the most citations appeared.

The most cited author is given here under:

RANK	S.No.	AUTHOR	ARTICLES
1	1	TERAMURA (AH)	22
2	2	CADWELL (MM)	20
3	3	LEE (DW)	11
4	4	LILLO (C)	10

The ranked list of most cited journals is given below:

RANK	S.No.	JOURNAL	PERCENT
1	1	Journal Of Plant Physiology	16.9
2	2	Physiologia Plantarum	9
3	3	Planta	4

The most popular forms in which the articles appeared is given below:

RANK	S.No.	FORMS	PERCENT
1	1	Journals	83.90
2	2	Books	10.98
3	3	Proceedings	1.18

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	30(4)	1985	167-174
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Annals	----------		

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